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(*Continued.*)

Morning session, Thursday, January 1, 9.30 a. m.

PRESIDENT P. J. PARROTT: As the vice-presidents of the Association are not present I will ask Dr. W. E. Hinds to preside during the time the address is being discussed.

CHAIRMAN W. E. HINDS: The first business on the program is the discussion of the President's address, which was delivered yesterday.

MR. HERBERT OSBORN: I think all the members of the Association appreciate the President's address. I presume we found little in it to criticise or serve as a basis for prolonged discussion. I certainly appreciate what the President had to say and believe that this is a good time to express this appreciation.

MR. C. GORDON HEWITT: I would like to add my expression of appreciation for the President's address as representing another country which is closely allied to the United States in its economic progress. We in Canada owe very much to the early entomological work in the States, although our work began very early and our development has been along similar lines to those outlined in the address. The early efforts in Canada began in the Province of Ontario in the same way as the early efforts in the States began in Massachusetts. I think from that viewpoint the development or origin of economic work is very interesting, especially as our work began in connection with the agricultural work of the Province.

MR. T. J. HEADLEE: I want to thank the President for his paper. I think the information set forth should be of great help to the younger entomologists and I am glad that the President saw fit to take up this subject for his address.

MR. GEORGE A. DEAN: I wish to express my appreciation of the President's address and as one of the younger entomologists, it is certainly an inspiration to me to have reviewed the progress which has been made in entomology during the past fifty years and, particularly, the outline of progress made within the last few years. The work has now progressed to a point where we are reaching the farmer and he is securing direct benefit from it.

MR. A. F. CONRADI: I was interested in that part of the address where the speaker referred to the increased possibilities for research work since the passage of the Adams Act. In South Carolina this has resulted in preventing duplication of work and in increasing the force of men employed. The work has been centralized under one head so that it has become more efficient.

CHAIRMAN W. E. HINDS: If there are no other remarks I will retire and the regular program will be continued. Before doing so, however, I wish to congratulate our President on the address which he presented.

PRESIDENT P. J. PARROTT: The first paper on the program will be presented by Mr. J. A. Dew, entitled, Some Properties of Various forms of Arsenate of Lead.

SOME PROPERTIES OF VARIOUS FORMS OF ARSENATE OF LEAD

J. A. DEW

Up to the present time little detailed investigation of insecticides has been conducted in the Southern States. Owing to the fact that there are large numbers of leaf-eating insects present the greater part of the year, arsenate of lead is by far the most widely used insecticide. Arsenate of lead was first used for poisoning leaf-eating insects in 1892, and during the past twenty years great manufacturing interests have developed to supply the present day demand. Naturally, with a large number of manufacturers in the field, there are several different forms of arsenate of lead on the market, most of which can be placed in two classes, viz: first, acid, meta, or bi-plumbic ($PbHAsO_4$) and second, neutral, ortho, or tri-plumbic ($Pb_3(AsO_4)_2$); but recently there has appeared what is known as basic arsenate of lead. This last-mentioned form contains an excess of the base and was put on the market for special use in humid areas where the other forms caused injury.

The present paper is a preliminary report of the work done by the writer during the past year to determine just what forms of arsenate of lead are the most effective and what characteristics give the insec-

ticide its value. The most important point to be determined was whether or not the killing power of arsenates of lead varied directly with the percentage of As_2O_5. In order to get data on foliage effect, time of application, etc., at the same time determining the above points, a peach orchard was selected which was known to be infested by the plum curculio (*Conotrachelus nenuphar*). The trees selected were all of the Mayflower variety, five years old, and stood in a compact block, all the trees being equally distant from wooded areas. The spraying was done by the writer with a barrel pump, mist nozzle and under a pressure of 110 pounds. The first application was made just as the shucks began to slip, followed in thirteen days by the second. Besides the arsenate of lead the second spray contained self-boiled lime-sulfur wash (8-8-50). A period of drouth extended over the entire time covered by the experiment, April 12 – June 1. During April the precipitation was 1.4 inches (1.9 less than normal) and during May was .45 inches (3.4 less than normal). There were no washing rains, the total of 1.8 inches falling in showers on eight different days. The mean temperature during this time was 63.8°F.

All the data presented below is taken from daily records made in the orchard which include the record of the daily fall of fruit as well as of those picked and placed on the market June 1. The experiments were divided into two series. The first included those plots sprayed with a specific number of pounds, calculated on a dry basis of the different forms of arsenate of lead, and the second included those sprayed with a specific number of units of As_2O_5 derived from these same forms. The plots were made up of from eight to twelve trees and two from each plot were used as count trees. Below is given a table containing the data obtained from the first series.

TABLE I

Plot No.	Amt. dry Ars. lead	Form of Ars. lead	Units of As_2O_5	Percentage wormy	No. peaches in count
1	1 lb.	basic	19.99	11.8	1,069
2	1 lb.	neutral	25.60	10.1	876
3	1 lb.	acid	33.38	5.4	759
10	No spray	—check		37.4	646

Examination of these results indicates that the killing power of the arsenate of lead varies directly with the percentage of As_2O_5 that it contains.

The second series of the experiments was based upon the application of specific units of As_2O_5 derived from different forms of arsenate of lead and the results are as follows:

TABLE II

Plot No.	Amt. dry Ars. lead	Form of Ars. lead	Units of As_2O_5	Percentage wormy	No. peaches in count
3	1 lb.	acid	33.38	5.4	759
10	1 lb.	acid	33.38	4.9	865
12	1 lb.	acid	33.38	6.8	581
7	1½ lbs.	neutral	37.00	4.3	761
13	1½ lbs.	neutral	37.00	6.6	495
15	1½ lbs.	neutral	37.00	5.0	694
16	No spray	—check		37.4	640

NOTE.—Arsenate of lead as found on the market was used. As_2O_5 calculated on dry basis.

From the above table it is readily seen that when derived from the neutral or acid arsenate of lead, 33 units of As_2O_5 gave practically the same control as 37 units and that an excess of the units used above 33, therefore, does not give a corresponding decrease in the percentage of wormy fruit. This indicates also that the percentage of As_2O_5 and not the form, determines the killing power.

A different grouping of the data already given with the addition of the facts obtained from a plot (No. 4) on which 3¼ pounds of basic arsenate of lead was used will bring our two other points, viz.: basic arsenate of lead did not become available under the existing climatic conditions in sufficient degree to give good control, and second, an excessive increase of the number of units above 33 does not give a corresponding decrease in the percentage wormy.

TABLE III

Plot No.	Amt. dry Ars. lead	Form of Ars. lead	Units of As_2O_5	Percentage wormy	No. peaches in count
3	1 lb.	acid	33.38	5.4	759
10	1 lb.	acid	33.38	4.9	865
12	1 lb.	acid	33.38	6.8	581
13	1½ lbs.	neutral	37.00	6.6	495
7	1½ lbs.	neutral	37.00	4.3	761
8	1½ lbs.	acid	49.00	3.8	728
4	3¼ lbs.	basic	66.00	10.1	865
16	No spray	—check		37.4	640

The table above combined with the two previously given indicates the following facts:

1. The lowest number of units of As_2O_5 necessary to give an effective control of the plum curculio is 33 (Plots 13, 7, 8).

2. One pound of an acid arsenate of lead (33% arsenic oxide) has more killing power than a pound of neutral arsenate of lead (25%–27% arsenic oxide), and each more killing power than 1 pound of basic arsenate of lead (20 % arsenic oxide) (Plots 1, 2, 3).

3. Under similar climatic conditions, the killing power of an acid or a neutral arsenate of lead depends directly upon the percentage of As_2O_5 that it contains.

4. Basic arsenate of lead, under the climatic conditions prevailing while the experiment was being conducted, became too slowly available to give good results even when double quantities were used. In fact there was little difference between the effect of 1 pound and 3½ pounds. (Plots 1 and 4).

During this series of experiments, in fact within three days after the beginning of the examinations, two classes of fallen fruits were distinguished, viz.: those normally shed (peaches shed naturally by reason of overproduction, retaining the stem) and, second, those abnormally shed (peaches shed by reason of some injury, the stem remaining on the tree). After careful examination of the abnormally shed fruits they were divided into two distinct groups, viz.: those containing a feeding or egg puncture made by curculios or other insects, and second, those showing no insect injury but having a slight shriveled area at the base, caused presumably by the effect of spray solution which had collected at that point.

A careful daily record was kept of these classes of fallen fruits both from the sprayed and unsprayed plots. That the abnormal shedding which could not be attributed to insect injury was due to the effect of arsenicals is indicated by the fact that the unsprayed check plots gave less than 2 per cent of this class of fruits. However, the figures given below show the results of these examinations.

TABLE IV

	No. peaches in count	No. peaches abnormally shed	No. punctd. Shed by insects	Not punctd. No cause assigned	Percentage	
					Insect	No cause
Sprayed....	10,181	3,208	2,224	984	69.3	30.7
Unsprayed .	6,331	5.113	5,019	94	98.1	1.9

Note.—No sprayed plots showed burning of foliage to any large extent although sprayed trees shed a few more leaves than those not sprayed.

Believing this shedding to be caused by the arsenicals contained in the spray the next points to be determined were: What form of arsenate of lead causes the most shedding and does the shedding vary directly with the units of As_2O_5? The data accumulated on this point is given below.

TABLE V

[illegible]	Units As_2O_5	Abnormal shed	Form of Ars. lead	No. shed. No cause	Percentage shed. No cause
[illegible] & C	33	555	acid	238	42.8
[illegible] & B	37	821	neutral	267	32.5
[illegible] & D		6,331	....	94	1.9

From these figures it is clearly seen that the plots sprayed with acid arsenate of lead lost more of the unclassified peaches than did those where a neutral product was used, although on the neutral plots more units of As_2O_5 were used.

In the next table is given the relative shedding on three plots sprayed with 1 pound of basic, neutral and acid arsenates of lead.

TABLE VI

Plots	Units As_2O_5	Form of Ars. lead	Abnormal shed	No. shed. No cause	Percentage shed No cause
1	20	basic	219	78	35.9
2	27	neutral	187	91	48.5
3	33	acid	96	45	46.8
16-D			6,331	94	1.9

From this comparison it is quite clear that there is no direct ratio between the units of As_2O_5 and the percentage shed. This is further evident by the following:

TABLE VII

Plots	Units As_2O_5	Form of Ars. lead	Abnormal shed	Shed. No cause assigned	Percentage shed. No cause assigned
1	20	basic	219	78	35.9
4	65	basic	190	75	39.4

From the four tables given in this section of the paper, the following facts are indicated:

1. That when used in accordance with the spraying practices of the present day, all trees sprayed with the different forms of arsenate of lead used in these experiments, shed a comparatively large number of fruits showing no insect injury.

Constant characteristics of these fruits are that the stems remain on the tree and the fruits show a slight shriveling at the base.

2. That the number of these shed fruits varies with the form of arsenate of lead used and that the acid forms causes the greater percentage of loss.

3. That this shedding does not vary directly with the units of As_2O_5 used, but apparently depend more on the form of arsenate of lead.

MR. J. A. DEW: I wish to say that the suggestions in this paper are not conclusions, but some points came up while the work was being conducted and I thought it might be interesting to the members of the Association to bring them forward at this time. The work was

originally intended for a local experiment but is now an Adams project under Doctor Hinds, Auburn, Ala., and this paper is presented with his permission.

MR. W. E. HINDS: I wish to bring out one point which I think is of interest. In the applications that have been made we found indications of a shedding due to the direct arsenical effects of the spray. Some of the fruit that was shed from treated trees had certain characteristics by which it could be distinguished from fruit shed from untreated trees. The question has been brought up in connection with these experiments as to the extent of this shedding due to arsenical application. The percentage varies considerably when the neutral and acid forms of arsenate of lead are used. As far as I know this point has not been considered heretofore. I would suggest at this time to those who have arsenate spraying projects under way that they see whether any way could be found to offset the shedding of unpunctured fruit.

MR. W. M. SCOTT: Was there any difference noted as to the effect of different forms of arsenate of lead on the foliage?

MR. W. E. HINDS: We had practically no injury. There were a few burned areas but not enough to be of economic importance.

PRESIDENT P. J. PARROTT: Mr. A. L. Melander will present the next paper entitled, "Can Insects become Immune to Spraying?"

CAN INSECTS BECOME RESISTANT TO SPRAYS?[1]

By A. L. MELANDER, *Entomologist, Washington Agricultural Experiment Station*

There is a prevalent feeling in some districts that sulphur-lime is less efficient now than formerly in controlling San José scale, or orchard aphides, or the brown mite. This has been largely ascribed to the general adoption of the factory-made clear solution which is popularly regarded as subject to a mysterious adulteration.

There seems to be no question but that some years and in some places sulphur-lime is a rapidly acting insecticide. In Piper's elaborate experiment at Wawawai, Washington, in 1902, he repeatedly found all the scales dead a week after the application. The same is true of some Wenatchee scales I examined two years ago. At the same time that these Wenatchee scales were counted, specimens from Clarkston, Washington, sprayed two weeks before, showed 90 per cent alive. Even with 26° sulphur-lime, ten times stronger than a normal application, 74 per cent of the scales were still alive.

In the experiment of 1902 Piper discovered that sulphur-lime was

[1] Contribution from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 75.

equally effective whether applied one pound of sulphur to three gallons, or one pound to six gallons. I noted the same in some tests at Clarkston in 1908, but discovered that here and there on certain branches were individuals that were still alive a month after spraying, although as well covered by the spray as the others. This experiment was repeated in 1910 at Walla Walla, Washington, with the same results, except that a considerable number of the scales, averaging more than 10 per cent, was still alive.

For several years the San José scale has been increasingly prevalent in the Clarkston Valley. The growers have erected a local sulphur-lime factory in the effort to control faulty preparation of the spray; they have drenched their trees by power spraying in the endeavor to overcome faulty application, and yet the scale has uncontrollably spread. Some branches I examined in 1912, that had been given three applications, at intervals of about two weeks, using a hot sulphur-lime of the 30:40:100 formula, showed 50 per cent. of the scales still alive under the crust of dried spray.

This led us last spring at the Washington Station to try identical solutions in a number of localities, and then to make bi-weekly counts of the proportion of living and dead scales,—an experiment we were able to carry on through the help of the Adams Fund. Clarkston, Walla Walla, Kennewick, Prosser, Sunnyside, North Yakima and Wenatchee were the localities selected, comprising an air-line circuit of four hundred miles, and at each place materials from the same stock were used. In the course of the bi-weekly visits made to these places upwards of 350,000 scales were individually examined under the binocular microscopes, by my assistant, M. A. Yothers and myself.

PERCENTAGE OF LIVING SCALES

	No. Yakima				Sunnyside				Clarkston			
	When sprayed	2 weeks	4 weeks	6 weeks	When sprayed	2 weeks	4 weeks	6 weeks	When sprayed	2 weeks	4 weeks	6 weeks
1. Sulphur-lime 5°	92	57	30	0	95	60	6	0	95	90	77	[illegible]
2. Sulphur-lime 3°	92	80	51	0	95	78	3	0.5	95	92	81	[illegible]
3. Sulphur-lime 2°	92	75	40	0.5	95	76	4	0	95	90	76	[illegible]
4. Sulphur-lime, 1:½:5	92	88	35	0.1	95	93	2	0.2	95	93	75	[illegible]
5. Sulphur-lime, 1:2:5	92	50	22	0.2	95	58	4	0	95	77	52	[illegible]
6. Spramulsion	92	44	2	2	95	50	7	2.4	95	70	40	[illegible]
7. Orchard Brand Oil Spray	92	6	0	0	95	13	0	0	95	4	1	[illegible]
8. Fuel oil emulsion	92	60	0	0	95	91	0	0	95	62	0	[illegible]

For the sake of brevity the accompanying table shows the results obtained at but three of the places, North Yakima, Sunnyside and True's orchard, Clarkston, selected because the conditions for the

experiment were ideal in each of these cases. The trees were vigorous, the scales abundant, the applications thorough and bad weather did not interfere. The figures show the proportion of scales rated as alive at the successive bi-weekly counts. The first experiment represents 5° factory-made sulphur-lime, approximating one pound of sulphur to three gallons. The second, 3° sulphur-lime, or one pound to five gallons, the third 2°, or one pound to seven gallons. Then follow two sulphur-limes prepared just before the application, experiment four, 3°, corresponding to the second experiment, and number five, with the same amount of sulphur but with four times the chemical requirement of lime. The sixth test gives a carbolated emulsion, called Spramulsion, prepared on the Pacific Coast. The last two represent oil sprays made with a fish oil emulsifier: Thomsen's Orchard Brand and a fuel oil emulsified during the tests.

It will be observed that the normal action of the sulphur-lime is continuous, producing complete destruction of the scale in a little more than a month's time. In the Clarkston experiment, however, from 4 to 13 per cent, or more, of the scales were alive six weeks after spraying, at which time they had begun their spring growth and were probably but little susceptible to whatever weathered sulphur-lime remained.

Attention may be called to the similarity of the results obtained with the last two oil sprays at all three places, showing that Clarkston scales have no resistance to these sprays, and to the similarity of the action of sulphur-lime used at North Yakima and Sunnyside, as compared with Clarkston. It is evident from these figures that the San José scale at Clarkston manifests a decided resistance to the action of sulphur-lime.

Although sulphur-lime has come to be regarded quite as a panacea, because of its destructive action on fungi, lichens, insect eggs, scales, etc., yet it is specifically a scalecide, and particularly is used against the San José scale during its hibernating condition. Other scales are less susceptible, the naked Lecaniums not at all, and thick shelled or active insects emerge quite unharmed from a bath of sulphur-lime. Even the San José scale shows a variable susceptibility, for during the growing period sulphur-lime has proved to be much less effective. Furthermore, there is a sex-difference, for among the resistant individuals escaping the action of the spray, the majority are males. Sulphur-lime is not a universal poison; it does not assure certain destruction of all insects; and there is thus a chance for an immunity to manifest itself in increasing degree as the insects become acclimatized.

The physiological effect of sulphur-lime is believed to be due to

a chemical reduction of the insect, an action that is vigorous at first but after a few weeks or days gives place to a chemical deposit of sulphur. The effects are thus not altogether immediate, but prolonged, and the reactions grow weaker day by day. That the San José scale is able to resist the first shock of deoxygenation is evident from the abundance of living scales for several weeks after the application.

It is a difficult matter to determine just when a scale insect dies. A killed scale becomes dry in a few days, during which time its protoplasm changes from a pale yellow juicy condition, through a viscous sirupy stage, to a darker yellow oily meal. This reaction is not reversible, and thus differs from the first effects of dessication, from which insects may be revived. In making counts of the scales we rated as dead all insects that showed gelation of the protoplasm when crushed under the microscope.

That the San José scale should become acclimatized to a sulphur-lime environment is not altogether a strange thing. There are organisms living in sulphur springs, in thermal springs, in hypertonic salt and alkaline lakes, and even in petroleum wells,—all of them environments fatal to normal forms. An example of such abnormal species in the making can be readily observed in an estuarial tension life-zone, where the salt water forms are invading the fresh water region, and the fresh water species are becoming adapted to the recurring tides.

One of the strangest instances of acclimation is the case of arsenic eaters. By consuming repeated small amounts of arsenic the body becomes immune to many times the normal lethal dose. When arsenic spraying for leaf-eating insects is imperfectly done it is quite possible for the insects to get daily homeopathic doses of arsenic and to become progressively resistant. Indeed, Mr. R. W. Glaser of the Bussey Institution, has experimentally verified this supposition in his work with the gipsy moth. By successively administering more and more spray, he tells me that he has succeeded in rearing a series of moths from larvæ that finally were feeding on heavy dosages of arsenate of lead. Indeed, these larvæ were especially hardy, and developed as strong an immunity to disease as they did to the arsenic. This may be the underlying reason why spraying for half-grown caterpillars and grasshoppers is usually so ineffective.

While immunity to arsenic may be a greater factor in the control of insects than we at present know, yet it is an adaptation of the individual only. We do not know that such an acquired immunity affects subsequent generations, although it would not be inconceivable that arsenic antibodies are passed on by the mother into the egg to give the offspring some initial immunity.

The resistance of the San José scale, however, is of a different kind. Spraying affects every tenth generation or so, and it is quite unlikely that an acquired immunity should make its effects felt over so long a period. Sulphur-lime spraying in the orchard districts is compulsory by law and so practically every scale is subjected to its action. We have often noted an individual scale, or a group of scales, probably brothers and sisters, still alive in the midst of a mass of dead insects. Such vigorous individuals have been just as thoroughly wet with the sulphur-lime as their neighbors, yet have escaped its action. The sporadic occurrence of naturally immune individual scales finds a parallel in recent work on heredity of protozoa and bacteria. Mutants less or not susceptible to certain toxins have been repeatedly found in cultures and from them have been produced immune strains. Similarly, disease-resistant wheat has been produced through Mendelian segregation, the new strain acting as a pure recessive.

The data at present at hand do not permit us to determine whether resistance and susceptibility are differences of degree and not of kind, or whether they behave as allelomorphs. That the mortality curve of the Clarkston scales is less steeply inclined from the beginning might indicate a partial immunity already possessed by nearly all the scales, but which is pronounced enough to be an absolute immunity only in a relative few. Such a view is especially interesting when we recall the reported rapid action of sulphur-lime a few years ago.

What is the economic importance of the appearance in a locality of a resistant strain of the San José scale? An alarmist might say that a few such scales would soon result in a totally immune insect, brought about by annual spraying. But viewed from a Mendelian standpoint, the consequences are less direful. If only the resistant individuals survived to reproduce then a pure line might result after repeated sprayings. But always there are some scales missed by the spraying, and these, during the ten generations between sprayings, will produce a population in part, at least, non-resistant. If resistance were a dominant characteristic there would already be a larger proportion of immune individuals than the data show. If it is recessive the crossing with scales missed by the spray would, by the end of each year, produce a majority of susceptible individuals. Thus we may make the strange assertion that the more faulty the spraying this year the easier it will be to control the scale the next year.

Practically, a change from sulphur-lime to an oil spray is all that is necessary for effectual control. However, even in the case of the oils we have noted a very few individuals that have manifested a remarkable tenacity of life. Should these result in a resistant strain sometime in the future it would be necessary to use both insecticides,

and then if the same individuals were doubly resistant we might have to introduce a weak strain of the the San José scale to cross with the immunes and thus return to the normal susceptible population.

PRESIDENT P. J. PARROTT: This is a very unique paper and ought to provoke considerable discussion.

Question: Are the records on the chart the result of a single year's experiment or combined results of several years?

MR. A. L. MELANDER: The curves were built up from last year's work at three different places.

Question: Can you tell us why the Clarkston results were not as good as the others?

MR. A. L. MELANDER: I tried to explain in the paper that I believed that the Clarkston scales possessed a hereditary resistance to the lime-sulphur spray. This may possibly be due to the fact that they have been subjected to this spray longer than any other place, for the lime-sulphur has been used longer in that valley in Washington than anywhere else in the northwestern part of the country.

MR. W. C. O'KANE: I was interested in what the speaker had to say in regard to the immunity of caterpillars to arsenic. I would like to know whether, after the first or second spraying, the caterpillars were increasing in size, and resistance, and were consuming much more than a dose which would ordinarily kill them?

MR. A. L. MELANDER: He told me that they were feeding and consuming many times as much poison as should ordinarily kill them.

PRESIDENT P. J. PARROTT: Can Doctor Wheeler give us any figures on the experiments which were conducted by Mr. Glaser?

MR. W. M. WHEELER: Mr. Glaser did not advise me in regard to the results of these experiments. I think they were taken up in connection with other work.

MR. E. P. FELT: I would like to ask Mr. Burgess if it is not a fact that when the gipsy moth caterpillar becomes nearly grown it is very difficult to destroy it with poison.

MR. A. F. BURGESS: Yes, that is true. If spraying is done when gipsy moth caterpillars are nearly full-grown it is very difficult to kill them. I think Mr. Glaser must have secured these results in connection with other experiments which he was carrying on.

PRESIDENT P. J. PARROTT: In using the lime-sulphur wash we have found from past experience that spraying may not kill the parent, although the treatment is destructive to the progeny. Has this been your experience?

MR. A. L. MELANDER: Considering the results from a chemical

standpoint the effect is weaker day by day. In the cases mentioned the lime-suphur wash was effective within a week after its application.

PRESIDENT P. J. PARROTT: We have conducted some comparative experiments in New York with the polysulphides of barium, calcium, sodium and potassium. The percentage of scales killed by the different compounds ranged from about 94 to 100 per cent. The calcium and barium preparations were uniformly more effective than the other mixtures. With all of the polysulphides there was some breeding, which was more noticeable on the trees sprayed with the sodium and potassium mixtures. This difference in effectiveness we attributed to the greater solubilities of the latter compounds.

Question: What results did you have with the polysulphide of calcium?

PRESIDENT P. J. PARROTT: The barium polysulphide was the most efficient preparation, while calcium polysulphide ranked as a close second in effectiveness.

A member: I have noticed that we cannot get good results with lime-sulphur wash after the 1st of April, that is, after the trees begin to grow actively. For some unknown reason the scales are not killed after this time.

PRESIDENT P. J. PARROTT: The next paper will be read by Dr. E. P. Felt on "The Reactions of Sugar Maples to Miscible Oils."

THE REACTION OF SUGAR MAPLES TO MISCIBLE OILS

By E. P. FELT, *Albany, N. Y.*

(Withdrawn for publication elsewhere.)

MR. GLENN W. HERRICK: Have you noticed any effect as to the time of spraying and have you any data on the effect of miscible oils on other trees than maples?

MR. E. P. FELT: Most of the injury we observed in certain cases followed spraying in the fall. We have studied several apple orchards where a serious condition developed, the damage being closely restricted to trees or even parts of trees which had been treated with a miscible oil.

MR. Z. P. METCALF: Our experimental results have shown that miscible oils are not the only thing that cause injury. A few years ago at Charlotte, N. C., I found three trees in three widely separated localities showing practically the same injury to the lower branches. One was a sugar maple which was not infested by insects and had not been sprayed. Another a silver maple which had been sprayed the previous

year with lime-sulphur wash and the third was sprayed the same year with soluble oil on the lower branches. The lower branches of all three showed practically the same effect, as near as I can judge, as those mentioned by Doctor Felt. It was, however, a very unusual condition. I would like to ask Doctor Felt if he has found this condition in trees that have not been sprayed with miscible oil.

MR. E. P. FELT: We have observed trees in apparently the same condition, though in our own experience a close examination has shown differences from the symptoms which we have noted as following the application of miscible oils.

MR. W. M. SCOTT: As I understand it this injury was confined to sugar maples; other maples were not affected by this spraying?

MR. E. P. FELT: My observations in this particular case related to the sugar maple and the ordinary soft or white maple. The latter seem to be fairly tolerant, the sugar maple quite susceptible to injury.

PRESIDENT P. J. PARROTT: The next paper will be presented by Mr. L. M. Peairs, entitled, "The Relation of Temperature to Insect Development."

THE RELATION OF TEMPERATURE TO INSECT DEVELOPMENT

By L. M. PEAIRS, *Morgantown, W. Va.*

At meetings of the American Association of Economic Entomologists held in Chicago in 1907–1908 and in Boston in 1909, Director E. D. Sanderson, then of the New Hampshire Experiment Station, presented papers dealing with the relation of heat to the various activities of insects, notably with the effect of heat on development, distribution and hibernation of insects.[1] The papers were based on an accumulation of data taken by him at the New Hampshire Station and included some results from other sources. The last paper had also a résumé of the existing theories of the effect of heat upon development and showed some of the weaknesses of those theories, at the same time advancing theories of his own on the subject. These theories, as worked out by the writer from the data of Director Sanderson with additions from other sources, have proved to be remarkably sound. The theory offered for the proper method of computing accumulated temperatures (Jour. Ec. Ent., Vol. III, pp. 136–137) is shown in the present paper to be correct. Fig. 10–15 and the accompanying discussion well illustrates this point.

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[1] Journal of Economic Entomology, Vol. I, pp. 56–65, 245–262, and Vol. II, pp. 113–140.

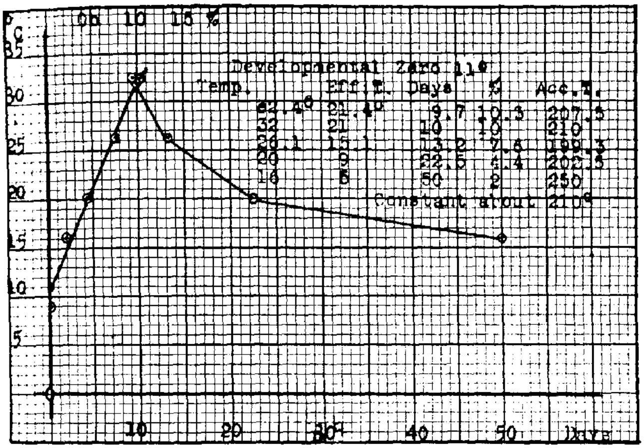

Fig. 10. Pupæ of *Malacosoma americana*. Drawn from data by Sanderson.

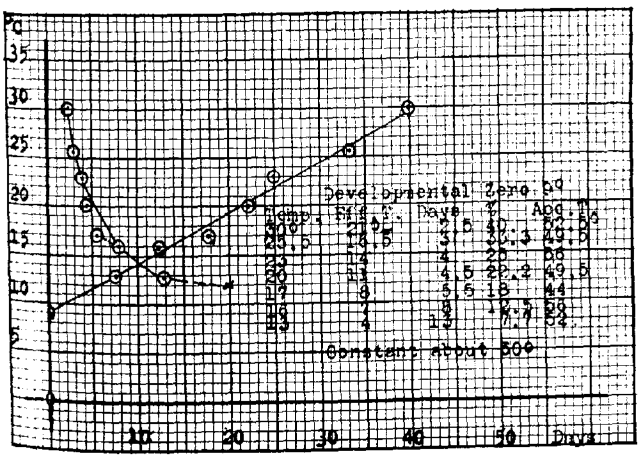

Fig. 11. Eggs of *Heliothis obsoleta*. Adapted from Sanderson, Jour. Ec. Ent., Vol. III, p. 125.

The aim of the present writer has been then, to develop the theories of Director Sanderson and prove or disprove them; to formulate such laws as might be found to govern the action of temperature conditions on insect development, and by so doing, to place the study of temperature in this connection on a more definite basis than it has been heretofore.

This work has been done at the West Virginia Experiment Station under the direction of Director Sanderson, and the full statement of the results, as well as the data upon which they are based, is soon to appear as a bulletin of the New Hampshire Station where the work was started and most of the data taken.

The study has seemed to prove the following points and we would therefore propose them as tentative laws:

1. The rate or velocity of insect development is affected by temperature, and, other factors being constant, this rate increases in direct proportion to the increase in temperature, *within the normal limits of development.*

2. The curve expressing the increase in rate of development is a true hyperbole.

3. The Developmental Zero or what has been styled the "Critical point," is at or near the point where the reciprocal curve for the time factor intersects the temperature axis.

4. The thermal constant for an insect or any stage of an insect is the constant for the developmental curve for such insect or stage.

5. The effective temperature for conditions of variable temperature, *i. e.*, the ordinary daily variations, is higher than the mean for the period. (This point is not supported by any evidence in the present paper but there is little doubt in the mind of the writer that it will be found to be correct.)

The first law is not new but has been generally recognized for many years. It therefore needs no discussion. The second one has not, so far as we know, been definitely stated in any published paper. The proof is the shape of the curves plotted from experimental data and the shape of the reciprocals plotted from these curves. One of the properties of an hyperbole is that the reciprocals plot to a straight line. Another is, that the product of the two factors establishing any point on the curve is equal to the product of the factors establishing any other point on the curve; in other words, it is a constant. The shape of the reciprocals from the experimental curves is graphically shown in the figures. On the figures is shown the accumulated temperatures for the different points establishing the curves. These theoretically, should be constant. Their near approach to the constant, under experimental conditions, is additional proof as to the nature of the curve.

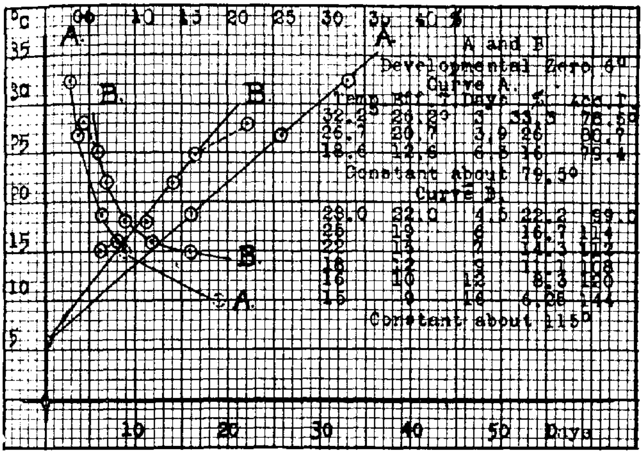

Fig. 12. A. Eggs of *L. decemlineata*. Drawn from data by Sanderson. B. Eggs of *C. pomonella*. Drawn from data by Hammar, Bu. of Ent., Bull. 115, Pt. I.

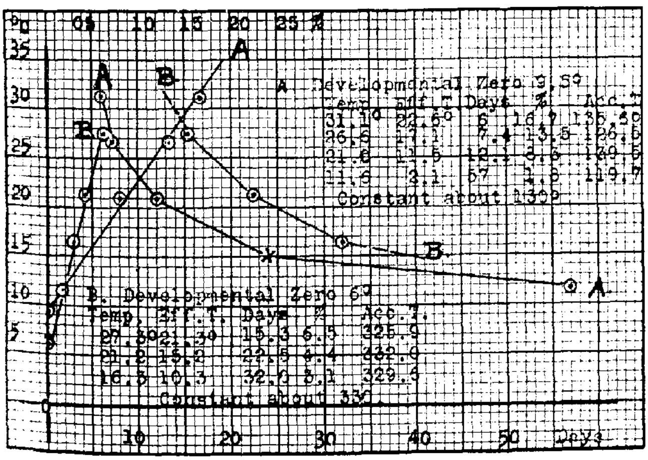

Fig. 13. A. Eggs of *Tenebrio molitor*. B. Larvæ of *Euproctis chrysorrhoea*. Drawn from data by Sanderson.

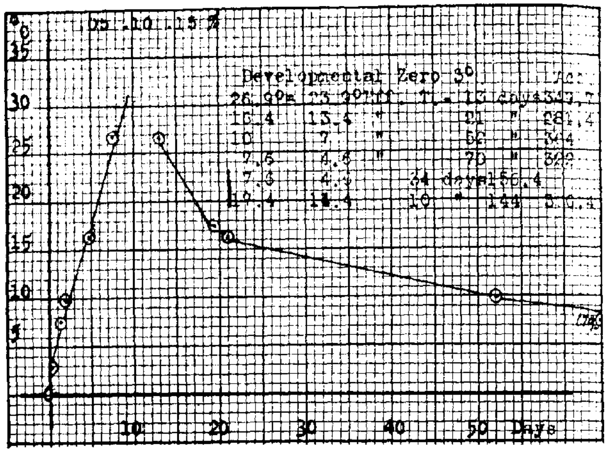

Fig. 14. Eggs of *Porthetria dispar,* after cold storage conditions. Drawn from data by Sanderson.

NOTE.—The co-efficient for a day at 7.6° is .014, at 17.4° it is .05, the value of a day at 17.4° being 3.6 times that of a day at 7.6°.

.014 x 34 days gives .486
.05 x 10 days gives .50

Total .986 as opposed to the theoretical 1.00. Also: 10 days at 17.4° equal 10 x 3.6 or 36 days at 7.6°. Adding this to our actual 34 days at this temperatute we have a theoretical 70 days as opposed to 70 days for the lot kept in 7.6° until emergence. Conversely, 34 days at 7.6° equal 34 divided by 3.6 or 9.5 days. Added to the 10 days actually spent in the 17.4° temperature we have a theoretical period of 19.5° as opposed to an actual experimental period of 21 days for a temperature of 16.4°.

Law No. 3 is based to a certain extent on theory. We know that the point in question is, and by definition must be, the zero for the curve. That it is actually, also, the zero for the development of the insect would seem theoretically probable and the evidence all points to the truth of this assumption. For instance, we have insects completing their development at temperatures but one or two degrees above this temperature, while others within the same distance of the point, but below it, never develop.

Law No. 4 depends to a considerable extent upon the ones preceding. In computing the accumulated temperatures it is necessary to use, not the actual temperatures or number of degrees above an arbitrary zero as on the Centigrade or Fahrenheit scales, but the *effective* temperatures or numbers of degrees above the calculated developmental zero. It will be seen that these accumulations as stated above, in curves based on experimental data, approach a con-

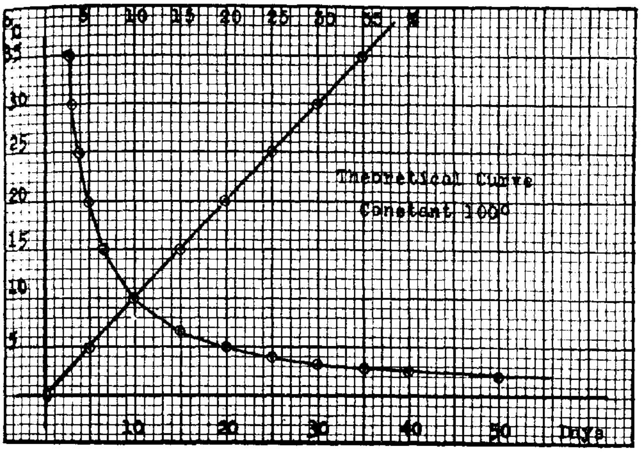

Fig. 15. A true mathematical hyperbole, showing the relation of the reciprocal to the curve.

stant in a manner highly satisfactory and seem to prove not only that there is a thermal constant, but that it is the constant for the developmental curve.

The fifth law proposed is based only partly on the same data as the others and is greatly strengthened by the results of later experiments, the reports from which are not yet ready for publication.

A study of the curves themselves and the data upon which they are based will help to an understanding of the conclusions advanced. The figures show only a very few of the typical ones but should serve to throw light on the methods of calculation employed.

If the above conclusions, however faulty they may be and however much the laws may need revision, help to place the study of temperature and its effect on the activities of insects on a definite basis, the writer feels that their presentation here will have been justified.

Question: I had always supposed that there was a certain point of optimum temperature for development and I do not understand how this idea conforms to the statements given in this paper. It would seem that the higher the temperature the more rapid the development without any limit. How can we adapt this idea to the figure that the speaker has exhibited?

Mr. L. M. Peairs: You will notice that I stated in my paper that the development increases within normal limits of development, and we have not worked out the top of the curve.

Mr. W. C. O'Kane: In examining the curve I see that some are computed from as few as three or four points. I want to ask Mr. Peairs if he feels that he had absolute control over moisture and light. It seems to me that where you are computing a curve and you have only three or fours points, that unless you have absolute control over moisture and light you may be misled.

Mr. L. M. Peairs: The control was not absolute of course. At the present time I am working with different species of flies and have incubators running where I am controlling both light and moisture and while I did not use any of this data in the paper presented, the information which is being secured seems to bear out the conclusions which have just been given.

Mr. C. Gordon Hewitt: I presume the same type of food has been used throughout the experiment. The rate of development is considerably influenced by the nature of the food as well as the factors of temperature and moisture. The chief interest in this work lies in the fact of the use we may be able to make of extremes in temperature. The sooner we get these facts, the sooner we will be able to secure value from experimental data of this sort.

Mr. V. E. Shelford: I would like to ask what precaution was taken in ventilating the cages?

Mr. L. M. Peairs: The ventilation was measured by pumps. In answer to Doctor Hewitt's question I will state that most of the insects under observation were either in the egg or pupal stages so that no food was required.

Mr. A. F. Conradi: The work in South Carolina has been directed towards securing moisture control. We have an elaborate machine by which we have tried to determine the moisture and the amount of air passing through the rooms. Heredity also comes in, as an important factor and should be given consideration as well as moisture and temperature.

Mr. C. Gordon Hewitt: We should take into consideration the hereditary disposition of the different stages.

Mr. W. C. O'Kane: If the transformations are computable on a mathematical or geometrical basis, how are we going to account for the delayed development of pupæ under natural conditions? In some places we have development occurring with some individuals within a few weeks after they are laid, while other eggs under the same conditions do not develop until the following summer.

Mr. L. M. Peairs: There are certain phenomena that actually occur in variance with our theories as presented. So far we have been unable to explain them on any grounds other than heredity, and heredity is a factor that we can not control in experimental work.

PRESIDENT P. J. PARROTT: We observe this phenomenon with the cabbage maggot. It will be necessary to bring this discussion to a close, and I will call for the next paper by Prof. W. C. O'Kane on "Further Experience with an Insectary."

FURTHER EXPERIENCE WITH AN INSECTARY

W. C. O'KANE, *Durham, N. H.*

Five years ago we built an insectary at the New Hampshire Experiment Station. The idea was to provide a permanent structure which would afford natural conditions for life history work.

The building was made 13 x 24 feet At one end is a wood structure 6 x 13 feet. This has solid walls and roof, two ordinary glass windows and an entrance door. From it another door leads to the open work-room.

The latter is 13 x 18 feet. It was made with removable screen sides set in a framework that could be taken down by removing bolts and screws. The roof of this work-room was of canvas and was made double, allowing air space between.

The entire structure is carried on a concrete wall rising 18 inches above the ground. In the small enclosed room a concrete floor was laid. The larger open room was provided with a cement floor down the middle. On one side of this are six concrete pits and on the other a strip of soil 2 feet wide. This strip of soil as well as the dirt in the pits is continuous with the ground beneath. A full description of the building, and photographs of it, will be found in the JOURNAL OF ECONOMIC ENTOMOLOGY, Vol. 2, page 389.

Experience with this insectary has led naturally to the proof of some advantages and the discovery of some disadvantages. The former are as follows:

The large, open work-room is an excellent place for carrying on some kinds of experiments through the summer season, especially such as require the use of small breeding cages. The temperature is the normal of the air. Humidity is normal. The bins and the earth strip provide fairly acceptable soil conditions, but not a normal amount of moisture in the surface layer.

In winter the frame work, screens and canvas top are removed. The open structure has then been used for general storage of hibernating material. The earth in the bins and in the strip has been used for earth storage. The closed section has served for storage under shelter.

The disadvantages discovered have been as follows:

For summer use the work-room can provide normal conditions only as regards temperature and humidity of the air. We have found

it better to carry out much experimental and other work in various cages erected in the open. If we wanted normal soil conditions we could get them only by the use of soil cages outside of the insectary. For other work tree cages or ground cages of various kinds, with or without a weather-proof top, and erected on normal soil, have proved not only better but necessary. It is our belief now that no permanent insectary can supply this need.

In winter we have come to consider that the storage of hibernating material can be accomplished easily and satisfactorily without making use of a dismantled insectary. Such material can easily be maintained under thoroughly normal conditions in temporary shelters, or on the ground under the protection of wire screening, or in the soil, or elsewhere, as the case may be.

In our rather severe climate it has been found that the dismantled part of the insectary tends to fill with ice and snow in winter. This is apt to be destructive of concrete.

Finally, there is no opportunity for winter work with living insects or plants.

In the light of the above experience changes have now been made in the insectary as follows:

We have retained the closed room entire, the foundations, bins, etc., of the open room, the removable frame work as far as the eaves, and the removable screen sides. In place of the double canvas roof, we have substituted a regular greenhouse roof, permanently set with glass. Glass sash, put on with screws, take the place of the wire screen sides in winter. Steam heat is provided in the former open workroom during the cold season, which, with us, lasts five or six months. No steam pipes run into the small, enclosed room, which can be kept cold, cool or warm by opening or closing the door to the larger room and by the use of ventilators.

The cost of these changes, complete, was about $250. This included $115 for steam pipes, asbestos covering, steam trap, and the labor charge for running an underground main from a near-by building. The new glass roof and sides cost $95. The carpenter's bill was $40.

The present plan, therefore, is to transform the insectary into a greenhouse through late fall, winter and early spring or as much of that as seems desirable. In summer the glass sides will be removed, the screen sides substituted, the roof will be coated thickly with whiting and if this does not provide normal temperature a canvas roof will be added above the glass roof with an air space between.

By this means it is our idea to retain the usefulness of the structure for summer work as in the past, and to add to this an equivalent usefulness through the winter season, which has not heretofore been true.

Much experimental summer work will continue to be done in the open, away from any permanent structure as formerly. Winter storage for material will be provided elsewhere without difficulty, and in some cases with conditions more nearly normal.

PRESIDENT P. J. PARROTT: I have no doubt that some of the members have in mind either building a new insectary or rebuilding an old one. The paper is now open for discussion.

MR. W. M. WHEELER: Our experience coincides very closely with that of Mr. W. C. O'Kane's. We have a glass enclosed greenhouse which we use only for winter work. As much work as possible is done out-of-doors so that natural conditions can be secured. We have a shed under which we keep pupæ in the winter. This problem has been under consideration for some time, but we have not yet decided whether to construct a new insectary.

PRESIDENT P. J. PARROTT: The next paper is by Mr. F. B. Paddock on "Some Observations on the Bee Moth."

OBSERVATIONS ON THE BEE-MOTH

F. B. PADDOCK, *College Station, Texas*

The bee-moth (*Galleria mellonella* L.) is an insect which has been known as a pest for over two thousand years.[1] However, during that time it has received but little attention from entomologists, though its occurrence has been noted from time to time in several countries. In Germany the habits and life history were briefly given in some notes made by Dr. E. L. Taschenberg in 1880.[2] In the United States limited observations have been made upon this insect. Perhaps the account by Prof. A. J. Cook[3] is the most complete as he has brought together the opinions of several writers. As far as we have ascertained the bee-moth is now found in Italy, Germany, France, England, Ireland, India, Australia, and in most of the bee-keeping sections of the United States.

THE ADULT. The moth is about five eighths of an inch (15 mm.) in length, and has a wing expanse of about one and one-quarter inches (30-32 mm.). When the wings are folded, the moth appears ashy-gray in color, though the rear third of the front wing is bronze colored. The dense covering of scales on the wings and the body is easily rubbed off

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[1] Manual of the Apiary, A. J. Cook, p. 485. "These moths were known to writers of antiquity, as even Aristotle tells of their injury, . . . they are often referred to by European writers as a terrible pest."

[2] Insekten Kunde, Vol. III, p. 251.

[3] Manual of the Apiary, A. J. Cook, pp. 482-487.

and is seldom present on the older moths. The males, which are slightly smaller than the females, are readily distinguished by a scallop on the outer margin of the fore wing and the absence of palpi.

The moths emerge entirely at night and usually during the early hours. In our cage experiments the moths started to emerge as early as 7 p. m. and none were observed to emerge after 9 p. m. During the day the moths seclude themselves from light and enemies and remain very quiet; in fact they are extremely hard to disturb and when forced to fly they act as though blinded by the light. An apparent exception to this is found in the females, for during the last two days of the oviposition period they are very active in depositing eggs. The males usually emerge a few days in advance of the females and live for a much longer time. In the case of the second generation it was found that the males lived an average of twenty-six days, which was twelve days longer than the average adult life of the females. The proportion of males and females is constantly changing throughout the generation but as a whole the number of males and females is about equal. The first and the last individuals to emerge in a generation are considerably smaller in size than the average, regardless of the sex. The last larvæ of a brood are always small as the food supply is never sufficient for all those which are present. A great many of these larvæ, though apparently not mature and forced into pupation, will transform into functional adults.

Mating has been observed but once and this was at 10 p. m. From this and the nocturnal habits of the insect in general, it may be assumed that mating occurs only at night. The mating probably takes place quite soon after emergence but there is no positive proof on this point. Females which were only one and one-half hours old were killed and examined to determine the condition of the eggs. It was found that at this time fully two thirds of the eggs were of full size and were well down in the oviducts though not packed so closely as was found to be the case in older moths. If mating does occur soon after emergence, some little time elapses before the beginning of egg deposition. For the second brood there is a period of six days between the emergence of the female and the first oviposition. This period, no doubt, varies with the different generations.

In the cages where empty comb was supplied, the eggs were always laid in cavities and if possible in such cavaties as were well protected. Only one egg is deposited at a time, though in working over a small piece of comb the eggs may be placed close together, apparently in masses. The eggs are always securely glued to their resting place; usually the shell will break before the egg is loosened. The number of eggs which are deposited by one female has not been ascertained

but moths which had not deposited eggs were killed and the eggs in their ovaries counted. The average number of eggs counted was 1,014. The time consumed in laying the full quota of eggs varies with the generation, averaging nine days in the first and seven days in the second.

THE EGG. The egg is elliptical, measuring about one fiftieth of an inch (.48 mm.) in length. The shell is pearly white in color and is slightly roughened by wavy lines running across it diagonally at regular intervals. Unless deposited on dark comb the egg is very difficult to see. The egg stage of the first brood averages twelve days and of the second only ten days.

THE LARVA. The larvæ when first hatched are white in color and one eighth of an inch (3 mm.) in length. Entrance into the comb is completed within two hours after hatching. This is made at the top of the cells between the cell walls. This entrance is soon shaped into a tunnel directed toward the center of the comb and is continued till the midrib is reached. The larvæ tunnel along the midrib, at first making only passage ways. Very soon these are outlined with silk threads which the larvæ spin wherever they travel and shortly these runways are densely covered. In a short time the center of the comb is only a mass of webs and refuse. After the midrib is destroyed the larvæ eat the walls of the cells, working outward parallel to the midrib. The cell walls are entirely eaten away but normally the tops of the cells are not disturbed so that the form of the comb remains unchanged. If the food supply is very short the larvæ will work over the refuse which contains considerable wax in small pieces. The length of the larval period of the first brood is forty-five days and in the second brood this period is shortened to thirty-five days.

The cocoon may be spun at the end of the feeding gallery or in the refuse but the most common place is about the hive body. Such places are the corners, between the hive-wall and the ends of the frames, and in the "bee space" at the ends of the top bars.

THE PUPA. The change from the larva to the pupa takes place during the night. When first formed the pupa is white in color but this darkens with age so that the old pupa is a dark brown. The pupæ average two thirds of an inch (14–16 mm.) in length. In the second brood the total time from the starting of the cocoon to the emergence of the moth is fourteen days.

LIFE HISTORY. From the work which has been done in trying to identify the generations of this insect, it appears that there are three at College Station. The third is not nearly as large as the first two, due to the fact that a portion of the second brood of larvæ do not pupate until late fall. There is a decided overlapping of generations,

which has made it difficult to determine the exact number that occur in a year. At most any time that an infested hive is examined all stages of the bee-moth may be found. From this it was generally assumed that the life history was short and that there were several generations each year.

In well-protected hives the development may continue throughout the year without interruption. But usually the winter is passed with about two thirds of the insects in the larval stage and the remainder in the pupal stage. Warm spells during the winter may cause some of the moths to emerge from their cocoons. In the laboratory many moths emerged when the temperature was maintained at 60° F. Such moths do not reproduce in localities where freezing temperatures are at all frequent. Even the most vigorous moths, when exposed, cannot withstand a freezing temperature for more than three days. Moths in well-protected places cannot survive an outside temperature of 26° F. longer than five days. The moths are never active during the day when the temperature is below 50° F.

For College Station, the following life history and duration of broods has been carefully determined.

The maximum number of moths which mature from the overwintering larvæ and pupæ appear about the first of April. These moths are active for some time before any eggs are deposited and it is the middle of April before the eggs are laid for the first brood of larvæ. Usually twelve days are required for the eggs of this brood to hatch, so by the first of May most of the first brood of larvæ are out. The larval period of this brood is quite long, most of them feeding at least forty-five days before completing their growth. A majority of the larvæ of this generation are ready to pupate by the middle of June, but there is a considerable variation in the rate of growth, as some of the larvæ feed for six weeks longer before completing their growth. The pupation of the first brood occurs during the last two weeks in June and by the first of July some of the moths of the second generation are to be seen.

The moths of this generation emerge at about the same time and give the impression of constituting a very large brood. Most of the eggs are laid very soon after the emergence of the moths and by the middle of July all of the eggs for the second brood of larvæ are deposited. The higher temperature at this time of the year shortens the egg period, only ten days being required for these eggs to hatch. There is a considerable variation in the maturing of this brood of larvæ. Normally the larval period is shorter than for the first brood and by the first of September many of the larvæ are mature. Some of the larvæ, however, may continue to feed for as much as four weeks longer and then pupate.

Some of the larvæ which mature early in September may pass through a short pupal period and soon emerge as adults. This accounts for the appearance of a number of moths about the first of October. This generation is usually small and scattered and many of the larvæ which result from the eggs of these moths seldom reach maturity. Some of the larvæ of the second generation do not pupate during the fall, but live over the winter in the larval stage and pupate the following spring.

The following summary shows the stages of the bee-moth which normally occur each month of the year at College Station:

April: Moths reach maturity from the over-wintering larvæ and pupæ.
  Eggs are deposited.
May: Eggs hatch.
  Larvæ are about three-fourths grown.
June: Larvæ are reaching maturity.
  Some pupæ.
July: Pupæ.
  Adults of the second generation.
  Eggs deposited by the second generation of moths.
August: Larvæ of the first generation.
  Pupæ of the first generation.
  Moths of the second generation.
  Eggs of the second generation.
  Larvæ of the second generation.
September: Pupæ of the first generation.
  Moths of the second generation.
  Eggs of the second generation.
  Larvæ of the second generation.
  Pupæ of the second generation.
  Moths of the third generation.
  Eggs of the third generation.
October: Larvæ of the second generation.
  Pupæ of the second generation.
  Moths of the third generation.
  Eggs of the third generation.
November: Larvæ of the second generation.
  Pupæ of the second generation.
  Larvæ of the third generation.
December: Same stages as during November.
January: Same stages as during November.
February: Same stages as during November.
March: Pupæ.

NATURAL ENEMIES. Three hymenopterous parasites of the bee-moth have been recorded. One is a chalcid, *Eupelmus cereanus*, found by Rondani in Italy; another is a braconid, *Bracon brevicornis* Wesm., which was found by Marchal in France; the third species is *Apanteles lateralis* Halid., recently found by A. Conté in France.[1] This last

[1] "A Hymenopterous Parasite of the Bee-Moth," A. Conté. (Compt. Rend. Acad. Sci. Paris, 154, pp. 41–42.)

species was found near Lyons where it spread very rapidly. It is apparently of considerable importance since it has also been reported to attack other Lepidoptera in England and Germany.

A small red ant, *Solenopsis* sp., has been found an enemy of the bee-moth, as many of our cage experiments were destroyed by this ant killing the moths and larvæ. The attack is made upon the moths in the day when they are at rest and the abdomen is all that is carried away. The larvæ are attacked during the day and those which are not well protected are sure to be eaten by these ants.

ARTIFICIAL CONTROL. Unfortunately, none of the above mentioned parasites of the bee-moth have been observed in Texas. Therefore it is necessary for the bee-keeper to depend entirely upon artificial control of the pest. For this purpose fumigation has proven the best means of fighting the pest. In our experiments two materials were chosen, carbon bisulfide and sulfur.

From these experiments it is evident that only extremely large doses of sulfur will affect the eggs of the bee-moth. The results indicate that the fumes are not ordinarily penetrating enough to be effective if the larvæ are well protected by their webs.

In the experiments with carbon bisulfide it was found that the eggs of the bee-moth were not injured by the ordinary doses. These experiments, however, showed the effectiveness of the fumes of carbon bisulfide upon the larvæ of the bee-moth. It was found that the pupæ are susceptible but a longer confinement in the gas is necessary to kill them. The moths were also found very susceptible to the fumes as they were killed in twenty minutes after being confined.

So successful was carbon bisulfide in the control of the bee-moth that tables were compiled showing the dosage necessary for varying numbers of supers and hive bodies containing infested material and these amounts have been found effective in actual practice.[1]

MR. A. F. CONRADI: Do you find ants in the hives?

MR. F. B. PADDOCK: Ants in beehives are very rare.

PRESIDENT P. J. PARROTT: The next paper will be read by Prof. Glenn W. Herrick on "Oviposition of Two Apple Pests."

[1] The tables are given in Bulletin 158, Texas Experiment Station, "Investigations Pertaining to Texas Bee-keeping."

THE OVIPOSITION OF TWO APPLE PESTS

By Glenn W. Herrick, *Ithaca, N. Y.*

The Green Fruit Worm, *Xylina antennata*

For the past two seasons the green fruit worms have been prominent among the insect pests of apples, pears, and, in some instances, sour cherries. In 1896 they were also abundant in western New York and caused considerable injury. At that time, Professor Slingerland made observations on the injuries, distribution, habits, and life histories of the three species concerned.[1] He surmised that the moths deposited their eggs in the spring. It is stated in a newspaper article that appeared in the South that the eggs are deposited in the spring on the undersides of the leaves. So far as the writer is aware the eggs of *Xylina antennata* have not been described or figured.

In the spring of 1913 several battered specimens of *Xylina antennata* were brought to the writer from Holley, N. Y. The moths were reported as occurring in abundance in an apple and pear orchard. We immediately wrote and requested that more specimens be sent and on March 22 four fine fresh moths were received in good condition. It was amazing that they had been able to pass the winter so well preserved. It is, of course, possible that these moths had transformed from overwintering pupæ, but hardly probable considering the early date at which they appeared.

These moths were placed in a breeding jar in the insectary with some apple branches that had been brought into the house early and were just coming into leaf. Some moistened sugar in a shallow dish was set in the cage where the moths could find access to it. On March 23 several eggs were deposited on the branches. They were laid separately in the scars of the branch (Fig. 16), particularly in the leaf scars of last year's terminal buds.

The egg is whitish or flesh-colored and inclined to pinkish. It is circular, somewhat dome-shaped but much flattened on top. The base is flat and the sides are ridged and grooved. There are apparently eleven primary ribs converging toward the micropyle with usually two secondary ribs between each pair of the primaries. In general appearance, the egg is remarkably like that of the cotton leaf-worm moth. In diameter the eggs range from .55 to .65 mm. The vertical diameter is somewhat less. By March 25 the eggs had turned much darker and were more pinkish in hue. They gradually grew darker and hatched on April 1. The incubation period then, under the conditions in the insectary, was nine days.

We have said that the eggs were deposited in the leaf scars on the

[1] Bull. 123, Cornell Univ. Agri. Expt. Stat. 1896.

branch. On March 29 we transferred the four moths to a new cage containing a short apple branch with a few small leaves. Here the moths deposited more eggs, three of which were placed on the undersides of the leaves.

On April 19 the writer spent a day searching for eggs in the apple and pear orchards near Holley in which the moths were found. It was an exceedingly raw, uncomfortable day with a strong wind from the north. In the whole day's search we were rewarded with only one egg. This was deposited near the tip of a small branch of pear in a leaf scar. Undoubtedly there were more eggs present in the orchard, although it was perhaps a little early in the season for them to be deposited. At any rate, the larvæ were rather numerous in this orchard later in the season.

Fig. 16. Eggs of the green fruit worm on a twig.

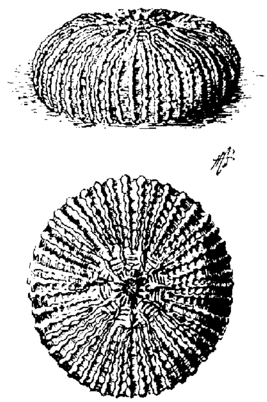

Fig. 17. Eggs of the green fruit worm greatly enlarged.

On this same day, April 19, Mr. R. W. Braucher, who had seen the eggs in the insectary and whom I had asked to watch for them in his orchard work, sent me a single egg laid on an apple bud near Batavia, N. Y. There seems to be no question but that at least some, if not the majority, of the eggs of this species are laid on the branches before the leaves appear.

The larva is pale green with a brownish green conspicuous head. When they were five days old they measured about 3 mm. in length. On the dorsum are two rows of tiny, black tubercles, each tubercle

bearing a black bristle. Just above the spiracles on each side is a row of black tubercles. The thoracic legs are brownish-green. In the second instar the larva begins to assume the appearance of the adult. The rows of tubercles have become whitish in color and two faint whitish lines begin to show along the dorsum.

The young larvæ eat almost entirely on the undersides of the leaves. They eat small, shallow cavities in the epidermis of the leaf but as they grow they eat holes entirely through the leaf. The larvæ under observation came to maturity on a diet of leaves and buds.

The Palmer Worm, *Ypsolophus pometellus* (or *ligulellus*)

In the past the palmer worm has been notable for its "ups" and "downs." Heretofore it has been considered rather an erratic pest of apples but apparently it is becoming a much steadier and more reliable enemy of the fruit-grower. In 1900 it appeared in western New York in great numbers and caused much injury. Since that time it has apparently been present more or less every year in the orchards of the state and during the past two seasons has been of considerable importance.

In 1900, Professor Slingerland worked out the life history of the palmer worm in some detail and endeavored to get the moths, which appeared during the first part of July, to lay eggs.[1] The moths lived in cages until about November 1, or nearly four months, but did not deposit eggs. It was evident that the moths hibernated and Slingerland hazarded a guess that they laid their eggs in spring on the branches or opening leaves in May.

On May 21 of the spring of 1913, Mr. R. W. Braucher sent me some moths for identification. He said they were rather numerous among the apple trees and that several were in the open air insectary which was located in the orchard. I recognized the moths at once as those of the palmer worm. They were in remarkably fresh condition and the writer at once asked Mr. Braucher to either send several to Ithaca or to confine them in cages there in the field in order to obtain eggs if possible. On the receipt of my letter Mr. Braucher was able to capture only two moths which he confined in an ordinary jelly tumbler on May 27 with a few apple leaves. On the morning of the 31st of May he found a number of eggs on the leaves, which he immediately sent to me.

Fig. 18. Egg of the palmer worm moth, greatly enlarged.

[1] Bul. 187, Cornell Univ. Expt. Stat. 1901.

In an examination of the leaves which were badly wilted I found in all fourteen eggs. They were tucked away among the hairs on the undersides of the leaves. Some were deposited in the angles of the veins, but the majority were scattered irregularly over the surface. They were very small and inconspicuous. The eggs varied somewhat in shape but, in general, were elongate oval and slightly pinkish in color at the time they reached my hands. Each one was sculptured with an irregular network of veins. The measurements of four ran as follows:

LENGTH	WIDTH
.52 mm.	.29 mm.
.49 mm.	.29 mm.
.50 mm.	.30 mm.
.49 mm.	.30 mm.

Braucher says that probably the eggs were laid on the 30th of May as that was the first warm day they had had since he put the moths in the glass. The eggs hatched on the 6th of June, thus giving an incubation period of about seven days.

The drawings by Miss Stryke show well the shape and characteristics of the eggs of these two apple pests.

PRESIDENT P. J. PARROTT: The data given in this paper is of special interest to economic entomologists in New York because, as Professor Herrick has said, there has been little or no definite knowledge on the oviposition habits of these two pests. Not knowing that Professor Herrick has been working with the green fruit worms, Mr. Fulton of the Geneva Station has been studying also the life histories of several Xylina moths. He has succeeded in obtaining eggs from six or seven species. The eggs of several of these are very similar in appearance.

The next paper will be presented by Prof. Herbert Osborn, entitled "Economic Notes on Leaf Hoppers in Maine."

ECONOMIC NOTES ON LEAF HOPPERS IN MAINE

By HERBERT OSBORN, *Columbus, O.*

(Withdrawn for publication elsewhere)

PRESIDENT P. J. PARROTT: We will now listen to a paper by Prof. R. A. Cooley, entitled "Notes on Two New Pests of the Currant and Gooseberry."

TWO NEW INSECT PESTS OF CURRANTS AND GOOSEBERRIES

By R. A. Cooley, *Agricultural College, Bozeman, Montana*

The Montana Experiment Station is giving some attention to the life history and means of controlling the currant fruit fly (*Epochra canadensis* Loew), and in this connection has found a small curculio, *Pseudanthonomus validus* Dietz, destroying the fruit of the currant in a manner very similar to that employed by the dipteron mentioned. The U-shaped larva of this beetle, feeding in the seeds, causes the fruit to turn prematurely red and drop to the ground. The injury occurs somewhat earlier in the development of the fruit, than in the case of *E. canadensis*. No injury is done to other parts of the plant so far as we have observed.

This species has been under observations in the college currant patch, of about an acre, for three seasons. In 1911 and 1912, the injury was severe, but no accurate estimate was made; in 1913 careful countings and estimates showed a destruction of fully 40 per cent of the fruit that set. Compared with the currant fruit fly in 1913, detailed countings of each kind of larvæ in four lots each of fifty injured currants, gathered from both the bushes and the ground, showed the weevil to be more abundant by three to one. From our experience, it is clear that while in some years the fruit fly is more abundant, in others this weevil is more destructive, and the two together in average years destroy much of the crop.

The adults appear in the spring by the time the young currants are setting. Numerous punctures are made with the long beak on different parts of the fruit, particularly around the point where the stems are attached, and in the pits by the stem the eggs are laid. The larvæ hatching from the eggs pass to the center of the fruit and begin feeding on the small seeds. They reach full size by about the time the currants are full grown. The injuries caused by the beetles close around the stems result in a drying and weakening of the tissues at this point and the currants are easily broken off. It is probable that a considerable portion of the feeding is done after the currants drop and we have found the large larvæ and fresh pupæ in the shells of the fruit on the ground. The pupal stage is passed in the destroyed fruit. From the pupæ, the adults emerge, are found for a short time on the bushes and then burrow into the ground for hibernation.

The periods required for the development of the various stages have not been determined, but the approximate seasonal history is clear and may be summarized as follows: The adult beetles pass the winter in hibernation appearing in the spring and laying eggs on the young

fruit. Egg laying begins in Bozeman about June 1, and by about July 15 the bulk of the feeding is completed and pupation has taken place. The fresh adults begin to appear on the bushes about July 20 and continue until about August 1, when all have disappeared, having gone into hibernation.

Detailed descriptions and control measures are left for future publication. We are indebted to Mr. W. Dwight Pierce for the determination of the name of this beetle. Mr. Pierce has also determined for us a parasite which was bred in considerable abundance from this beetle as *Catolaccus* sp. The common name, "The Currant Fruit-Weevil" is proposed for this insect.

For several years we had noticed a peculiar injury to the tender, terminal growth of gooseberries and red and black currants in Bozeman. The leaves of the affected stems were distorted, undersized and showed distinct spots or markings which suggested the attacks of some insect with piercing mouth-parts. The injured stems were reduced in size and in length and, as all of the stems on the bushes were more or less affected, the bushes showed distinct injury. The cause of the injury was explained when in 1912, a large black thrips was found feeding on stems which showed such injury. A number of the living insects were placed on fresh gooseberry shoots in the insectary and the young were reared. Since then we have repeatedly found both adults and young on gooseberry and currant and it is perfectly clear that a definite and characteristic injury which at times may be rather severe is attributable to this species.

Specimens were sent to Mr. J. Douglas Hood of the United States Department of Agriculture, who found them to be of a new species which he names *Liothrips montanus* (See "Nine New *Thysanoptera* from the United States," J. Douglas Hood, Proceedings Biological Society of Washington, Vol XXVI, June 1913, p. 163).

More recently this insect has been found in Sixteen Mile Canyon in Montana, feeding on the native wild gooseberry (*Ribes setosum* Lindl.) and causing the same characteristic injury.

The details of the life history and habits have not been worked out, but the following notes may be given:

The adults appear on the bushes soon after growth starts and later the young, which are bright red with black head and legs, may be found. The hatching of the young is strung out for several weeks. The first young appear about the middle of June and we have found young just hatched on July 12; in the latter part of July only adults are found and these disappear during the summer. The species apparently hibernated as an adult.

Preliminary tests with insecticides have been made, using commer-

cial lime-sulphur solution testing 27° Baumé, and with "Black Leaf 40" and soap, the tobacco extract being in the proportion of 1 to 1000. The lime-sulphur solution killed many of the thrips, but the "Black Leaf 40" was distinctly more effective, destroying practically all of the insects. The spraying was done on July 9, 1912.

At Bozeman this thrips is more particularly a gooseberry pest, but currants are frequently attacked. Of the two currants mentioned, the black species (*Ribes nigrum*) is distinctly preferred. As a common name for this insect we propose "The Currant Thrips."

President P. J. Parrott: These insects discussed in this paper are examples of the surprises that attend the work of the entomologist. Recently our attention has been called to a snout-beetle that has never been recorded as being of economic importance, but which occurs on sandy soils in New York where peaches are grown. It appears in the spring and feeds on the young leaves of the peach. During some seasons it causes quite a little injury to young peach trees.

Adjournment.

Afternoon session, Thursday, January 1, 1.30 p. m.

President P. J. Parrott: Dr. C. Gordon Hewitt will present the first paper on "The Occurrence of the Warble Fly (*Hypoderma bovis*), in Canada."

THE OCCURRENCE OF THE WARBLE FLY (*HYPODERMA BOVIS*), IN CANADA

By C. Gordon Hewitt, *Ottawa, Can.*

(Withdrawn for publication elsewhere.)

Mr. Herbert Osborn: Have there been any recent importations from Europe?

Mr. C. Gordon Hewitt: I don't know. Of course, we are receiving cattle from Europe all the time.

President P. J. Parrott: Do you know anything about the distribution of *H. bovis* in the United States?

Mr. C. Gordon Hewitt: Except for the reference of Johnson of its occurrence in Vermont, I know of no other records. My object in presenting this short paper is to have the entomologists in the United States on the lookout for this insect. The species in the United States has always been referred to as *lineata*.

President P. J. Parrott: The next paper is by Dr. H. T. Fernald, on "Control of the Onion Thrips and Onion Maggots."

NOTES ON THE ONION THRIPS AND THE ONION MAGGOT

By H. T. Fernald and A. I. Bourne, *Amherst, Mass.*

The "Onion Blight" is very common and serious in the onion-raising districts of New England. The trouble is caused by *Thrips tabaci* Linde., which is widely dispersed over the country, and the loss caused by this insect is often great.

Studies on this pest extending over a period of about five years have now been completed in Massachusetts, and have given the following results:

The insect passes the winter as the adult in any protected places available. These are generally in the refuse left on the onion field, in rubbish heaps, or at the base of the grasses on uncultivated fields and along roadsides near the onion fields. In spring, soon after the onions come up, the insects leave their winter quarters and pass to the plants, then usually an inch or two high. They locate on the leaves and begin to suck the juices and breed. The effect of the feeding upon the plant is first shown by the leaves attacked, which begin to bend rather sharply downward, bringing the thrips within the protection formed by the bend. This is due to the abstraction of sap from one place while the rest of the leaf is growing rapidly, so that in consequence the injured point is as it were, grown around by the uninjured portions. This condition is often evident by the time the plants are three inches high, and increases during the season, while other leaves become involved as the insects spread. Dying back from the tips soon appears, and in serious attacks either the entire plant may die or the bulb make only partial growth.

In testing different methods of control for this pest, the rather unusual methods used for raising this crop should be kept in mind. In New England at least, the land is fertilized broadcast and the seed sown in rows by seeders, and covered by a roller behind the seed spout. The rows vary in accordance with the ideas of different growers but their average distance apart is perhaps fourteen inches or less. The seed is sown so closely in the rows that some thinning is usually necessary where germination is complete, and a field of vigorous plants cannot be traveled over with a spray pump after these are more than six inches high, without causing serious injury to the leaves which tend to spread out, laterally. Any treatment, therefore, must be while the plants are small, and in some cases at least, the thrips spread to the field after the plants are really too large to permit of treatment without considerable injury.

The experiments were conducted on river bottom land used almost

exclusively for onion growing, the fields covering from six to ten acres and separated only by narrow strips of grass used as roads. Kerosene emulsion 1 to 5; whale oil soap, and tobacco whale oil soap were used in the tests. To bring the cost of treatment, particularly labor, within reasonable limits, a pump was placed on a hand cultivator and geared to the cultivator wheels while the discharge pipe was arranged to distribute to five nozzles placed opposite five rows, so that this number would receive treatment at once. It was soon found that with any gearing available a rapid walk was necessary to develop sufficient pressure, and that the speed required to obtain this pressure meant that a thorough spraying was impossible before any given plant had been left far behind. Possibly this mechanical defect might have been remedied, but hand tests of the material showed that it was practically impossible to reach enough of the thrips to make it worth while. The onion leaf is quite repellent to these materials, and as soon as the thrips has worked long enough for the leaf to bend downward somewhat the insect can be reached only by an underspray, and large numbers will be missed in any case.

As hand work at leisure was out of the question because of its cost, and as even with an effective machine an underspray cannot long be used before the growth of the plants would prevent its use by causing injury during the process, these treatments were given up. Instead, the careful destruction of all refuse after the crop was gathered, and the burning over of all strips of grass through and around the fields was advised. This practice has now been carried out for several seasons with good results. The growers of one large area have coöperated in this, and now find few thrips, and those which do appear, are most noticeable near the boundaries of the land which they control, apparently coming in from places where burning over has not been done in early spring. The adult does not appear to fly far of its own volition, and unless carried by strong winds it would seem probable that onion fields can, to at least a considerable extent, be kept clear of the thrips by running fire over all places near, in which they hibernate.

Another pest which has much injured the onion crop in Massachusetts is the onion maggot, the loss in some cases running as high as a hundred dollars per acre. In order to discover if possible some way in which the ravages of this insect may be prevented, experiments have been conducted for several years at the Experiment Station.

A preliminary study of the literature of the subject showed that numerous recommendations as to methods of control had already been made. A more critical examination, however, suggested the idea that some of these at least were more theoretical than practical,

and that it was extremely doubtful if any of them had ever been tested over as large an area as a single acre, even. In several cases it seemed probable that the person concerned had really experimented with the cabbage maggot and had merely inferred that a treatment successful there would also prove efficient in onion fields, not realizing that the different method of growing onions might affect the results.

After a prolonged study of the treatments advised, eight of the most promising were selected for trial, the others being prohibitive on their face, either because of the difficulty of obtaining the material in sufficient quantities for extensive experiment, its cost, or an evident great expense in its application. These eight were: carbon disulfid; nicine; powdered hellebore; hellebore decoction; soap wash; carbolic acid and lime; kerosene emulsion; and carbolic acid emulsion.

Time does not permit the presentation here of the details of the tests, which are given in the 25th Annual Report of the Massachusetts Agricultural Experiment Station. The results, however, are briefly as follows:

The carbon disulfid when placed near enough to the plants to protect them from the maggots, killed most of the plants. It is possible that a long series of tests would show that a certain amount placed at some certain distance from the plant would give protection without injury, but the application of any treatment, with the accuracy this would require, to a ten-acre field would be impossible except at a prohibitive cost. If a second treatment were necessary as would probably be the case, it would become still more impracticable, while the cost for a single application would be from $12 to $14. For these reasons, therefore, the carbon disulfid method may be dismissed as not feasible.

Nicine was tested mainly from curiosity to learn if it was an insect repellent as it was claimed to be. It was found to have no protective value, and at the prices quoted its cost would be prohibitive in any case.

Powdered hellebore dusted along the rows cost over fifty dollars for each application, including the labor. The treatment would need to be repeated at least once, and probably twice, bringing the expense too high. The results also, were far from satisfactory.

Hellebore decoction prepared according to Smith's directions (N. J. Bull. 200) seemed to give no protection whatever to the onions and the cost of material and its application three times would be greater than the average loss without treatment, even if good results had been obtained.

Soap wash using one pound of soap in ten gallons of water, poured along the rows, three times at intervals of ten days, gave only moder-

ately good results. The cost of the soap and of its preparation and application came to about $20 an acre for each application, bringing the cost too high to make it a desirable treatment.

Carbolic acid and lime also failed to give good results. Either the coating around the plants was too thin or the maggots went beneath it. After every cultivation or row weeding it was necessary to repeat the treatment, and the infestation of the treated rows was as great as of the untreated check rows. The cost of the material was not great but the application had to be carefully made in order to obtain a complete crust around the plants, and this took time. The total cost for one application finally figured out at about $23 per acre, which in view of the repetitions necessary after each cultivation would make the cost too great even if it had been effective.

Kerosene emulsions, one part to nine; to fourteen, and to nineteen of water, were applied like the soap wash and repeated at intervals of ten to fourteen days. The different strengths seemed to give no difference in the results and no injury to the plants or protection from the maggots was found. The total cost for one application per acre varied from about $20 to $24, which for three applications would be too high.

Carbolic acid emulsion gave the best results so far as protection from maggots was concerned, though not being entirely effective. The cost for the four treatments necessary would come to from $35 to $50.

The conclusions drawn from these tests were that none of the treatments are entirely satisfactory and that most of them are in any case prohibitive because of their expense. Accordingly, the problem may be formulated somewhat as follows: To find some material which will destroy or repel the onion maggot at a total cost of less than $50 per acre.

The greatest item of expense is, of course, the application of the material, and any method which will reduce this is of value. Each repetition of the application rapidly increases the cost, and if a substance can be found with which a single treatment will be sufficient, this will be a great advantage. If, then, this treatment can be combined with the planting, the extra cost will be mainly that of the material.

During the past season, therefore, an attempt has been made to discover some repellent which could be fed on to the seed from a supply tank just behind the seed spout and in front of the roller, which would keep the maggots away.

A number of materials were tested for this purpose, and it was found that some are injurious to the seed, preventing its germination, and

that others are too costly for use, even in this way. One or two promising substances have been found, however, and farther tests of these will be made during the coming season, as it is, of course, unwise to rely upon the results obtained in a single year.

Mr. Herbert Osborn: Have you noticed any effect of dry season on the breeding of onion thrips and does a dry season show any reduction in the injury caused by this insect?

Mr. H. T. Fernald: Dry seasons may check the injury to a certain extent after a time, but at first the insects seem to increase rapidly. At one time I thought this insect was distinctly a dry season species. Later it did not seem to be affected so much by dry weather.

Mr. Herbert Osborn: My experience has been that it migrates into onion fields during the dry periods.

Mr. H. T. Fernald: Dry weather usually begins in New England about the 1st of July and at that time our onion fields are so thoroughly stocked with thrips that no further migration to them is necessary.

President P. J. Parrott: Is this species a common pest on cabbages in Massachusetts?

Mr. H. T. Fernald: I have not noticed it to any extent.

President P. J. Parrott: As regards the maggot, Mr. Schoene has been working with a similar insect which attacks cabbage, and has found that carbolic acid emulsion is not a satisfactory treatment. We rely on screening the seed-beds to protect seedlings.

Mr. W. D. Hunter: Has anyone tried naphthaline? This substance has been found to be very destructive to several species of root maggots. I have tried it on cabbage, turnips, and radishes, but not on onions, and it gave the plants practical immunity.

A member: I have tried naphthaline alone and in combination with other materials and found that it controlled both the maggots and the growth of the plants.

President P. J. Parrott: One of our cabbage growers has made it a practice of planting a moth ball with his early cabbages.

Mr. W. J. Schoene: The cabbages do not grow very well, however.

Mr. Henry Skinner: Naphthaline might be used in the liquid form. It is one of the best materials to use for household insects because it can be applied so as to seal every hiding place.

President P. J. Parrott: The next paper is entitled "A New Destructive Cutworm of the Genus Porosagrotis Occurring in Western Canada," by Mr. Arthur Gibson. It will be read by Doctor Hewitt.

A NEW DESTRUCTIVE CUTWORM OF THE GENUS POROSAGROTIS, OCCURRING IN WESTERN CANADA

By ARTHUR GIBSON, *Chief Assistant Entomologist, Division of Entomology, Ottawa, Canada*

In June, 1911, reports reached the Division, from southern Alberta of extensive injury to grain crops owing to the ravages of cutworms. From material received two moths were reared which were determined at the time by Mr. F. H. Wolley-Dod as *Porosagrotis delorata* Sm. A brief record of one instance where a correspondent claimed to have lost 320 acres of wheat, before June 21, was referred to in my bulletin on cutworms (No. 3, Dominion of Canada, Division of Entomology, February, 1912), and Dr. C. Gordon Hewitt also referred to the outbreak in his annual report, as Dominion Entomologist, for the year ending March 31, 1912. This was the first occurrence on record of this cutworm as an injurious species; in fact, the insect had hitherto been looked upon as an extreme rarity in Canada.

During the first half of May, 1912, farmers in the neighborhood of Lethbridge, Monarch, McLeod, and other places in southern Alberta, noticed large numbers of the cutworms in their fields. Mr. W. H. Fairfield, superintendent of the Experimental Station at Lethbridge, reported that the first noticeable damage to crops was on May 6. A correspondent at McLeod, Alberta, 32 miles from Lethbridge, stated that the cutworms began to attack fall wheat about the middle of April. Other crops destroyed were spring wheat, when it came up about the beginning of May, oats, barley, beets, onions, cabbages, carrots, etc. Many acres which were in spring wheat, and which had been destroyed later, were sown to oats in early June, and this crop was also completely eaten. In some instances as many as three sowings were made. In the Lethbridge Land District, from the city of Lethbridge westward to Pearce, and northward taking in Diamond City, Monarch, Stanton and other immediate settlements, it has been carefully estimated that actually 33 per cent. of the grain sown was destroyed. From personal visits made to infested districts Mr. Fairfield stated that he was of the opinion that between 30,000 and 35,000 acres of grain had actually been destroyed by cutworms, in 1912, in the southern part of the Province of Alberta.

On May 10, 1912, larvæ collected at Lethbridge on May 6, were received at Ottawa. These were of different sizes from about half an inch to one inch in length. Some of these larvæ were full grown and entered the earth for pupation on May 28. The larvæ remained in the earth, no change taking place until June 18, when the first pupa was

observed. The moth from this emerged on July 19; others emerged later, the last issuing on August 21.

In view of the serious nature of the outbreak of 1912, Doctor Hewitt arranged for an investigation of life-history, habits, methods of control, etc., in the spring and summer of 1913, and I was instructed to plan these experiments and also to proceed to Alberta to begin the work and make a survey of the infested districts. Mr. E. H. Strickland was appointed to carry on the work in the field throughout the season to make a special study of this and other cutworms occurring in the province.

In the end of April and early May we found the cutworms fairly numerous, throughout the Lethbridge District, in spring wheat, fall wheat and oats. In certain places they were very numerous, as, for instance, at Iron Springs where they were present in some fields in numbers varying from 3 to 11 to the square foot. The larvæ on this date (May 6) were mostly from one fourth- to one half-inch long. In our field control experiments we divided infested fields into various sized plots, none smaller than one tenth of an acre each. These were treated with various strengths of Paris green, salt and sugar, mixed with moistened bran, and scattered, in the usual way, over the fields. London purple and lead arsenate were also used.

During our first series of experiments the weather was very dull and cool and the cutworms fed very little. The highest percentage killed in some of the plots was only 25 per cent. Even later experiments when the weather was warmer and the larvæ more active, unfortunately did not furnish satisfactory results. From observations made during the evening, by Mr. Strickland, it would appear that the habit of this *Porosagrotis* larva is to travel over the surface of the soil and when a suitable plant for attack is found, it immediately burrows and feeds just below the surface. One half-grown caterpillar was observed to crawl nine feet in fifteen minutes. If this underground feeding habit is fairly constant it will, of course, explain why we failed to get better results from poisoned bran. Further experiments will, of course, be conducted whenever the opportunity arises. It is interesting to note, however, that at Raymond, 26 miles from Lethbridge, in large fields of sugar beets the attack of 1912 was stopped within 24 hours after the bran was applied. The application of poisoned bran was made between the 10th and 15th of May, and the actual cost, including material and labor figured out at 30 cents per acre. When visiting Raymond on May 15, 1913, I was fortunate in reaching the sugar beet fields at a time when bran was being applied to protect this year's crop. Five men, a distance of 10 feet apart, were distributing the bran with both hands, from a sack hung in front of the body. The manager of

the sugar beet factory informed me that one man will cover 20 acres in a day. Five Japs distributed the bran over 30 acres in 3 hours—15 pounds of bran to the acre. One hundred pounds of bran poisoned with $1\frac{1}{4}$ pounds of Paris green, is used to cover 7 acres. No sugar or salt is added. About 1,500 acres of beets are under cultivation near the sugar beet factory.

DESCRIPTION OF LARVA. Length, when mature, from about $1\frac{1}{4}$ to nearly $1\frac{1}{2}$ inches; of a sordid, whitish, color; no markings on body. Thoracic shield brown with a whitish dorsal stripe. Spiracles black. Tubercles dark brown, setæ circled with white. Dark pulsating dorsal vessel, conspicuous in some specimens. Thoracic feet pale brown; prolegs concolorous. Head pale brownish almost concolorous with body, the only marking being a conspicuous band of dark brown on epicranium, bordering either side of clypeus and median suture, somewhat after the sides of the letter H; ocelli black; mouth-parts blackish.

STATUS OF THE INSECT. *Porosagrotis delorata* was described by Smith[1] from a single male specimen collected at High River, Alberta, which locality is 101 miles, by rail, from Lethbridge. From a study of the specimens which we have reared I am convinced that *P. delorata* is Morrison's species (*Agrotis*) *orthogonia*, described from Glencoe, Nebraska.[2] A specimen which I recently examined in the collection of Prof. T. N. Willing, of Saskatoon, Saskatchewan, and which had been collected at Regina, Saskatchewan, on August 10, 1904, was determined by Mr. F. H. Wolley-Dod as *Porosagrotis orthogonia*. In the *Canadian Entomologist*, XL, 102, March, 1908, Sir G. F. Hampson records a specimen under this latter name which was collected in Alberta.

MR. GLENN W. HERRICK: Was the poison mixed with dry bran?

MR. C. GORDON HEWITT: Enough water was added to make it easy to handle.

PRESIDENT P. J. PARROTT: The next paper is by Dr. W. E. Hinds entitled "Reducing Insect Injury to Stored Corn."

REDUCING INSECT INJURY TO STORED CORN

By W. E. HINDS, *Auburn, Alabama*

In economic value for the Southern States this problem is only second in importance to that of controlling the Mexican cotton boll weevil. The present interest in stored corn insect control is in some measure an outgrowth of the fight that is being made for better farming

[1] ... N. Y. Ent. Soc. XVI, 87, 1908.

[2] ... Boston Soc. Nat. Hist., XVIII, 239, 1876.

in the boll weevil campaign, which involves the reduction of cotton acreage, diversification and rotation of crops, the increase of live stock production, etc. All of this means for one thing more corn and longer storage for part of the increased crop. Within the past few years, the boys of the South under the guidance of the Corn Club movement have repeatedly demonstrated that the South can produce larger yields of corn per acre than perhaps any other section of the country, and withal can produce it more economically than any other section. Alabama presents two records that may challenge the world. In 1911, a fourteen-year-old boy, whose father was a county demonstration agent, produced over 212 bushels of corn on an acre at a cost of 9.6 cents per bushel. In 1913 another Alabama boy produced 232.7 bushels on a single acre, but his cost was between 19 cents and 20 cents per bushel. There is no longer any question that the South can raise her corn. The real question now is, can she preserve it from insect injury during storage, so that she may steadily increase her production until she raises at least all that she needs and can profitably utilize in her home consumption, which is bound to increase greatly in the near future, for the South is apparently destined to become the greatest section in this country for increasing meat production upon the farm.

There are several species of insects concerned in the injury to stored corn, and their relative importance varies in different sections. The most generally important of these species include two moths: the Indian meal snout moth, *Plodia interpunctella* and the Angumois grain moth, *Sitotroga cerealella;* three or four small beetles known generally as enemies of stored products: the rust-red and confused flour beetles, *Tribolium ferrugineum* and *T. confusum;* the square-necked grain beetle, *Cathartus gemellatus* and the saw-toothed grain beetle, *Silvanus surinamensis;* and more important than all these put together in most of the territory within 200 miles of the coast through the South Atlantic and Gulf States and extending still further inland in Louisiana, Texas and through Mexico is the so-called rice-weevil, *Calandra oryzae* L. This species is known so much more commonly here by the name of "black weevil" that we think this common name should be generally adopted. It is this species, the black weevil, that we have been studying especially and to which we shall refer particularly in the balance of this article. Fortunately, what is most effective for the control of the black weevil is effective likewise in reducing injury by most of the other species.

There are several phases to the question of loss caused by insects to corn, particularly during storage. This injury often affects seriously the value of seed corn in the South. Infested kernels are not

likely to germinate at all and if they do start the growth of the young plant is likely to be weak. This poor seed means often broken stands and weak or barren stalks which decrease yields generally. Beside this, the crop of early maturing upland corn is commonly seriously injured even before it is stored, and this injury is continued and multiplied during the storage. Late matured corn, such as is commonly produced on the wetter lowlands and river bottoms, is rarely seriously injured unless through being mixed with more heavily infested corn in storage. In the method of storage that is most common in the South, the corn is allowed to stand in the field until after frost occurs; then it is gathered, often when wet, with the whole husk left on and stored in very open cribs which are entirely unfitted for any fumigation treatment. The most common special practice for weevil control is to sprinkle the corn with salt or dust it with air-slaked lime, etc., as it is being stored. In these storage practices there are many elements that contribute to serious loss.

There is a large waste in the storage space required.[1] In studying several varieties of corn of widely different type, we have found that the space required to store corn that will yield one bushel of grain, is often from three to four times as great where it is stored with the full husk on as is required for the shelled grain. An average of the results for several varieties required for 56 pounds of shelled corn a year old, about $1\frac{1}{9}$ cubic feet; for the same corn, ears husked, 2 cubic feet; with "slipshuck" on, $2\frac{1}{2}$ cubic feet; and with the full husk on, 3.6 cubic feet.

The waste in actual corn destroyed is a yet more serious item. The corn crop of Alabama for 1912 was about 54,000,000 bushels. While this was less than two thirds of what the state used, it is probable that something like 10,000,000 bushels was carried through into the early summer of 1913 and suffered extensive insect injury. Much corn is simply riddled by weevils before the end of November. Chemical analyses together with weight determinations have shown that corn may lose fully two thirds of its nutritive value during a year's storage. The loss in feeding value is even greater since it becomes so repellant to stock that horses, cattle and mules and even hogs may reject it. Poultry alone eat weevily corn with relish. It is probably conservative to estimate the loss to Alabama's corn crop alone at 5 cents per bushel per month after November 1st, for about one half of our yield that continues in storage up to April and for all of the corn stored after

[1] There is quite a wide variation in the volume of given weights of corn shelled from the cob and in the space required to store different varieties with and without husk, etc. The volume of 56 lbs. of shelled corn has varied as widely as from 1.04 to 2[illegible] cu. ft.

that time. On this basis, Alabama's loss last year would reach close to $4,000,000 for nutritive value alone. Certainly the protection of corn against a large part of such loss would pay a handsome return if it can be secured at anything less than an average cost of 5 cents per bushel for the entire yield.

The net result of these most common practices may be summed up in one sentence: Not only do they fail to reduce insect injury to stored corn, but in many ways they even contribute largely to increasing that injury. The reasons for this conclusion will be shown briefly in succeeding paragraphs and from the many observations and experiments made, we shall attempt to formulate some recommendations as to methods that shall have real effective value in reducing insect injury.

Some Preliminary Facts from the Life History of *Calandra oryza* L.

Under winter climatic conditions, that are normal for central Alabama, there is no reproduction among the black weevils during about two months, ranging from the middle to last of December to usually about the middle or latter part of February. Immature stages then occurring in corn kernels develop very slowly, if at all. If unusually cold weather occurs, temperatures going to 12° F. or lower, there may be a very large mortality among both adults and immature stages. When winter temperatures do not go below 20° F. the total mortality may not exceed 10 per cent from the beginning of November to the end of March. At the end of March, 1913, in examinations involving about 7,500 weevils, only 11 per cent were found dead. Most of the corn ears examined were stored with husk on and thus retained probably all weevils that had died thereon since the infestation began in July or August of 1912.

Oviposition is actively resumed in the corn bins with the advent of warm weather in spring, by March or April at latest, and the first real spring generation emerges usually sometime in May. Females deposit eggs at an average rate of about four per day in hard corn. Weevils leave the corn cribs and apparently go to the fields in large numbers during the warm days from the middle of March to October. The height of this movement, as shown by cage trapping tests, appears to occur during July, by which time the second summer generation is out in the corn cribs and the corn in storage is then usually in very bad shape, while that in the field is in condition for attack.

In the fields, however, we know of no spring breeding place. Weevils may be taken occasionally in the field and they feed upon a large variety of subjects, but normal breeding does not seem to begin out of

doors until corn has passed its "roasting ear stage" and begins to harden up. When this condition of corn occurs, no matter what the date on the calendar, weevils seem to be ready for it and then, for the first time, come to the corn fields in large numbers. In several cases where most carefully studied, the weevils seem to have come most abundantly from the direction of the nearest woods. The earliest maturing corn—regardless of variety—attracts them in greatest numbers and, naturally, the ears that have exposed tips and loose, open husks are then the first and the most heavily attacked. For a brief period most of the weevils may be found upon the earliest maturing and most exposed ears on the plants scattered within perhaps 100 feet of the outer edge of the field. Gradually they spread farther inward until they are all over the field but naturally the corn from the outer edges of the field and the poorly covered ears throughout the field will always contain more weevils than any other equal number of ears.

These observations, together with the common experience that early-matured upland corn is nearly always heavily infested, while late matured river bottom corn escapes with practically no injury, point clearly to the feasibility of trap planting to concentrate weevils and of so handling our corn crop upon storage that heavily infested corn may always be kept separate from slightly or uninfested portions of the crop and the former treated for weevil control or fed out first, while the latter may be carried through long storage without necessity of treatment and with little insect injury.

Futile Remedial Practices

We have referred to the common practices of allowing corn to stand in the field until after a killing frost, of storing while wet and with the husk on, of sprinkling with salt, etc., to prevent weevil injury. These, and many other popular ideas we have tested carefully both in the laboratory and in large out-of-door storage bins constructed especially for experimental work with the black weevil, and we have found in nearly every case that they have practically no value in weevil control. A few of these ideas deserve specific mention.

It is commonly supposed that by leaving corn in the field until after a killing frost occurs the weevils on it are killed and that injury during storage is reduced accordingly. On the contrary, ordinary killing frosts such as occur at the beginning of the cold season have no killing effect upon either adults or immature stages. Doubtless the motionless condition of benumbed adults on the cold morning following a frost has misled the casual observer into thinking them dead.

Storing with the husk on is generally supposed to give more pro-

tection to the grain. On the contrary, it insures practically all of the weevils being successfully transferred from the field to the crib and in the crib the husk gives far more protection to the weevils already at work on the ears than it does to the corn.

The practice of storing while wet or of wetting as it is being stored is supposed to facilitate a heating of the corn which will destroy the weevils and not injure the corn. It is apparently true that it is possible by a natural heating of a mass of immature or damp corn to produce a temperature that will accomplish this result, and this does occasionally happen, but only in a very small fraction of 1 per cent of the attempts is the desired benefit achieved. It is safe to say that up to the present time we do not understand the necessary coincident conditions of degrêe of moisture, volume of mass, and tightness of crib, etc., well enough to advise anyone to depend upon this heating for weevil control. The much more common effect of this excess of moisture in the storage bin is to soften the grain so that the insects can work so much the faster and to multiply the molds and other fungi growing therein.

The salting of the corn renders the husks more palatable to live stock but, on the other hand appears to increase rather than reduce the insect attack. Salt naturally gathers moisture from the atmosphere in every prolonged period of high humidity and thus renders the corn softer and more susceptible to attack both of insects and of fungi. A practical test of this treatment with close observations as to the condition at beginning, during and at close of storage test, showed that the corn from the salted bin weighed only 0.9 as much for the same volume as did the average of nine other tests having corn from the same field, stored at the same time, also with the husk on but with no especial treatment. The corn from the salted crib was the lightest of any in sixteen tests and only 85 per cent as heavy as similar corn fumigated with CS_2 at time of storage or as untreated corn which had long, tight husk covering.

Weevil Resistance in Corn Varieties

It is a matter of common observation that different varieties of corn grown side by side, with all planting, cultural and soil conditions similar, may vary greatly in their susceptibility to or resistance to insect injury. The two most important factors in producing this variation are generally comparative rapidity in development to maturity of the grain and the relative length and tightness of the husk covering. For several years we have been growing side by side a number of the most promising weevil resistant varieties that we could secure and have compared these with commonly grown varieties which have

been included in the variety tests at the Alabama Experiment Station. We consider large yield, sound grain, thorough husk covering and pendent ears to be among the requisite characters and would rank varieties according to their possession of this combination of characters in largest degree. Work in breeding corn for these characters should give extremely valuable results in the near future.

Among the most promising varieties found to date are Experiment Station Yellow, a variety under selection for weevil resistance for many years past by the Alabama Experiment Station. It has repeatedly stood high in yield. About half of its ears are now pendent and about 80 per cent are exceptionally well covered. It also has a hard grain. Another variety, already widely planted, known as Whatley's Prolific has about 90 per cent pendent and 80 per cent of well-covered ears. Among less well-known varieties several deserve mention and further study. A new variety, known as Mayer's Prolific, supplied to us by Mr. O. H. Moyer of North Augusta, S. C., showed up remarkably well, having on 75 plants, 164 good ears of which 85 per cent were pendent and 97 per cent extremely well covered. There was almost no weevil work on this variety. Randall's Branch and U. S. D. A. variety No. 181 were quite good. Among varieties not especially resistant but widely planted, Hastings, Mosby and Marlboro Prolifics would rank quite closely together, while at the other extreme some large-eared varieties like Shaw and Henry Grady have a large percentage of ears with tips exposed and the weevil infestation usually runs high even before time for storage.

Recommendations for Future Practice

Looking at the problem from the point of view of protecting the 1914 crop as it is produced and stored, we may mention some of the main points in a system that will largely reduce the weevils and minimize loss during storage.

Seed Selection:—This should by all means be practiced in the field at the time of harvesting. Only at that time can proper attention be paid to several of the most important factors in corn improvement. If obliged now to depend upon crib selection, and the corn still has the husk on, we would select ears having tight husk covering in addition to other desired characters.

Trap Rows:—To protect upland corn, we should at planting time provide for a few rows to be planted either two or three weeks earlier or with seed of a more rapid maturing variety, so that it will mature earlier than the main crop and serve to concentrate the weevils thereabouts. Gather all ears with the husk on from these trap rows within six weeks after it passes the "roasting ear stage." This is to keep the

weevils on these ears and secure their removal from the field at such a time as we may have the maximum number of the old weevils thereon and before the first new fall generation will be ready to emerge and spread into the main crop. This main crop may also be harvested as soon as thoroughly matured.

Harvesting Methods:—Have the storage crib thoroughly cleaned and ready. For the main crop we would advise breaking the ears from the husk as it is gathered, thus leaving three fourths, at least, of the weevils in the field. Have the wagon-body fitted with a cross partition, so that the slightly infested corn may be kept separate from that already quite heavily infested. Of, if preferred, provide for the separation to be made as the corn is unloaded. Have boxes on each side of the wagon-body, or at its end, to receive the best ears from which the seed for next planting may be finally selected. At the crib in which corn will be carried longest in storage, leave only the soundest corn. Never mix good and bad ears in the long storage bin if possible to avoid it.

The many weevils that are shaken off into the bottom of the wagon should be swept out at some distance from the crib so that they will not be likely to find their way back to it. In these ways the storage period may be started with a minimum number of insects present.

Fumigation Treatment:—Where weevils are present in abundance at storage time and the corn cannot be fed out for several weeks, there is no better way to check insect injury therein than to fumigate with carbon disulphide. This should be done on a warm day and at least 20 pounds per 1000 cubic feet should be used. Small dosages are usually so much thrown away. A spring treatment in March is likely to be required and if the work is well done, there is little likelihood of another being needed. At this time of year fumigation is likely to have least effect upon the Plodias because the larvæ of that species wander away from the corn and seek pupation shelter in places where the treatment is not likely to reach them.

It will take many years to effect a general change in the methods of handling and storing corn in the South, but it certainly seems possible, through continued work along these lines, to save to this section a large part of an insect injury that now taxes us to the extent of many millions of dollars annually.

Mr. Henry Skinner: I would like to ask in what kind of receptacle the fumigation is done.

Mr. W. E. Hinds: Usually the entire mass of corn in the house is treated.

Mr. Henry Skinner: Are these temporary storage houses?

Mr. W. E. Hinds: No, they are permanent houses. We have advised many people to construct temporary fumigation bins.

Mr. Henry Skinner: It seems to me it would be feasible to have permanent storage houses suitable for fumigation.

Mr. W. E. Hinds: It is a question of expense. When a man has thousands of bushels of corn in storage it would be impracticable to construct fumigation cribs to retain the entire crop.

Mr. C. Gordon Hewitt: Is a single fumigation sufficient?

Mr. W. E. Hinds: All stages may be killed by one treatment but if many of the eggs were not killed a second fumigation would be necessary. We often make one in the early fall and another early in the spring.

President P. J. Parrott: Dr. C. Gordon Hewitt will present the next paper, entitled "Sterility of Oats caused by Thrips."

STERILITY IN OATS CAUSED BY THRIPS

By C. Gordon Hewitt, D.Sc., F. R. S. C. *Dominion Entomologist, Ottawa*

About five years ago specimens of oats with "blighted" ears or spikelets were received from Saskatchewan. The upper spikelets of the affected inflorescences were, as a rule, healthy, green and sound. The lower spikelets, however, were smaller, whitish and shrivelled and varied in size from slightly less than normal length to minute undeveloped ears. Specimens of oats similarly injured were received from correspondents in Alberta. A farmer who forwarded heads of oats bearing affected spikelets from Vancouver Island, B. C., stated that over 50 per cent. of a fourteen acre field of oats were attacked. In 1909, Mr. Angus Mackay, at that time Superintendent of the Dominion Experimental Farm at Indian Head, Sask., informed me that he had noticed the "Silver top" in oats for several years, but more particularly during the preceding year or two.

The discovery of dried up specimens of thrips in certain of the spikelets and in the leaf sheaths suggested that these insects might be responsible for the injury. Accordingly, in 1911 I investigated the matter more thoroughly in the experimental cereal plots, at the Central Experimental Farm, Ottawa, where injured or "blighted" spikelets of the same character were found in the oat plots, and it was clearly established that this form of sterility in the spikelets was produced by thrips. On these plots the common species and the one which was responsible for the injury was the Grass Thrips, *Anaphothrips striatus* Osborn.[1] Dr. W. E. Hinds kindly confirmed this determination.

[1] Bagnall (in "A Further Contribution towards a knowledge of the British Thysanoptera," Journ. Econ. Biol., 1912, p. 189) states "The Genus *Anaphothrips* Uzel should be known as *Euthrips* Targ.-Tozz."

Euthrips nervosus Uzel was also found. I was unable to find other records of this type of thrips injury at the time, except one which Mr. F. M. Webster showed me in 1910 in the Bureau of Entomology of the United States Department of Agriculture, Washington, D. C.; in this case *A. striatus* was recorded as injuring oats.

Since commencing this study several records have been given in European literature of thrips injury to cereals. Korolikoff (1910) has investigated a number of species of thrips injurious to cereals and grasses in Russia, in the neighborhood of Moscow. Straňák (1912) has investigated the species of thrips which caused unusual injuries to grain crops in Bohemia in 1912. Rye was most seriously affected from 25 to 100 per cent. being attacked, wheat varied from 5 to 70 per cent., barley varied from 5 to 40 per cent., and oats appear to have been the least attacked, varying from 2 to 20 per cent. On the average 29 per cent. of the spikelets were wanting and in the remainder of the injured spikelets the development of sound grain had been inhibited. A number of species of thrips were found to be responsible for the damage.

In discussing "White-heads" or "Take-all" of wheat and oats[1] the writer of the article states that much shrivelling of the grain and bleaching or silvering of the infloresecence in cereals and wild grasses is due to the activity of *Thrips cerealium* Halid. Zimmermann (1911) refers to *Thrips cerealium* Halid. occurring on oats, and his observations in Europe confirm my own made at Ottawa, namely, that early flowering varieties are less injured; most injuries being found on the later varieties where the emergence of the inflorescence is delayed. Miss Ormerod (1892) also referred to the shrivelling of the grain caused by the cereal thrips. Taschenberg (1880) records the injury caused by *T. cerealium* Halid. to the developing grain of wheat, rye and barley.

Fletcher recorded the occurrence of "White-top" in 1888 in June grass (*Poa pratensis*) and also in timothy (*Phleum pratense*) and couch grass (*Triticum repens*). While "White-top" in wheat is usually caused by the wheat-stem maggot (*Meromyza americana* Fitch) I have found specimens of such white-top in wheat which were undoubtedly caused by thrips. Comstock (1875) was the first to refer to "Silver top" or "White-top" injury by *Anaphothrips striatus* to June grass and timothy, and other entomologists including Hinds (1902) have subsequently recorded similar observations. Fernald and Hinds (1900) in their account of the grass thrips, *A. striatus*, refer to its extensive injuries to June grass.

In all the accounts of the injury of *Anaphothrips striatus* to June

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[1] Journ. Board of Agriculture (London), Vol. 19, p. 1020, 1913.

grass and timothy, the "Silver top" appearance is apparently caused by the thrips injuring the stems of the plants and thereby cutting off the supply of sap to the inflorescence. The adults feed upon the leaves and external parts of the plants; the larvæ feed chiefly within the leaf sheaths. This type of "Silver top" injury produced by *A. striatus* in the grasses mentioned is totally different in nature and in manner of origin from the injuries in oats which I am describing in this paper.

DESCRIPTION OF INJURY. The injury is chiefly confined to the inflorescence or panicle; the leaves of the plants were not affected to any noticeable degree. The injured spikelets are usually cream-colored, shrivelled and thin in appearance, contrasting vividly with the healthy green and plump spikelets, which fact facilitates detection in the field. The sterile ears vary also in length, that is, in development. I have found a similar type of sterility produced by thrips (*A. striatus*) in *Stipa robusta*. While the sterile spikelets are usually confined to the lower part of the inflorescence, as shown in Fig. D, for the reasons mentioned later, they may occasionally be scattered through the inflorescence or occupy a terminal position (Plate 7, A and B).

PRODUCTION OF INJURY. On July 13, 1911, different varieties of oats in the experimental plots of the Central Experimental Farm, Ottawa, were found showing the characteristic "blighting" of the spikelets. It was possible at this period of growth to make an examination of a large series of plants of different varieties showing all stages of growth from the young plants with the inflorescence completely enclosed to the full-grown plants in which the inflorescence was fully developed and extended.

Anaphothrips striatus Osborn, which has been popularly named the grass thrips, was responsible for the injuries which I am about to describe. The insects, both adult and larvæ, feed chiefly within the leaf sheaths; few were found externally. The inflorescence is attacked before it leaves the leaf sheath which encloses it. In consequence of this the thrips were more abundant in proportion to the extent to which the inflorescence was still enclosed by the leaf sheath; the more the inflorescence was enclosed the greater was the number of the insects found. The adult and larval insects feed upon the developing spikelets and produce complete sterility in the same by sucking the ovaries and feeding on the young anthers, in some cases two or three larvæ could be found on the base of a single floret. No larvæ were found above the edge of the leaf sheath, though they were occasionally found on the stem of the inflorescence between the lower florets. The injury to the florets is effected while the portion of the inflorescence bearing them is retained within the leaf sheath. In cases where the inflorescence had left the leaf sheath and no sign of injury to the lower

spikelet was noticeable only an occasional thrips could be found, but where the inflorescence had not left or had only partially left the leaf sheath, in every plant I examined thrips were found in varying numbers; their activity on disturbance made it impossible to count them.

It sometimes happens that when the inflorescence is emerging from the leaf sheath, the tip of the inflorescence is accidentally retained in the leaf sheath while the middle portion continues to unfold, the inflorescence assuming the shape of a mark of interrogation (?) with the distal extremity fixed. When this occurs the distal portion of the inflorescence is usually attacked by the thrips within the leaf sheath with the result that when it is ultimately withdrawn the terminal spikelets are sterile (Plate 7, Fig. 1, B).

A study of the different varieties of oats showed that those varieties in which the inflorescence left the leaf sheath earlier suffered less from thrips injury, that is they had fewer sterile spikelets at the basal region of the inflorescence, than the varieties in which the inflorescence was later in leaving the leaf sheath. I have already referred to the similar observation of Zimmermann in the case of *Thrips cerealium*.

Extent of Injury. In order to determine the actual extent of the injury, as field estimates are rarely within a considerable percentage either way of the actual injury, I made actual counts of the sterile and fertile spikelets on each inflorescence of stems gathered from different experimental plots. From these counts the actual percentage of sterile spikelets was obtained.

With a view to eliminating the possible chance of error due to personal selection of the plants from which the counts were to be made, I had the plants collected from different plots by a person who was unaware of the purpose for which they were intended.

The following figures [1] give the percentage of *sterile* florets found on the stems of the oat plants of the different varieties thus collected:—

"*Excelsior*." Outside plot, outside row. 12 stems counted.

Maximum sterile spikelets	52.2%
Minimum sterile spikelets	4.1%
Average sterile spikelets	30.9%

"*Abundance A*." Outside plot, outside row. 13 stems counted.

Maximum sterile spikelets	42.2%
Minimum sterile spikelets	15.6%
Average sterile spikelets	25.6%

Outside plot, inside row. 14 stems counted.

Maximum sterile spikelets	43.4%
Minimum sterile spikelets	16.8%
Average sterile spikelets	26.2%

[1] As there is no real necessity for setting out the figures in detail, the maximum, minimum and average percentages only are given, but I shall be pleased to give the detailed counts to any investigators to whom the same would be of value.

Oats Showing Sterile Spikelets Caused by Thrips (Original).

It will be noted that in the percentages of "Abundance" given above there is practically no difference between the extent of the injury on the inside and outside rows of the plot, indicating an evenness in the distribution of the insect over the plot.

"*Abundance, Garton's Regenerated.*" Inside plot, outside row. 11 stems counted.

Maximum sterile spikelets	38.8%
Minimum sterile spikelets	6.4%
Average sterile spikelets	17.3%

"*Banner H.*" Outside plot, outside row. 15 stems counted.

Maximum sterile spikelets	55.2%
Minimum sterile spikelets	3.5%
Average sterile spikelets	29.5%

"*Banner M.*" Inside plot, outside row. 19 stems counted.

Maximum sterile spikelets	56.8%
Minimum sterile spikelets	14.2%
Average sterile spikelets	36.3%

From the above results it will be seen that the most seriously injured variety of oats of those examined was "Banner M," 19 inflorescences of which variety had an average of 36.3 per cent. of sterile spikelets. The variety least attacked was "Abundance Garton's Regenerated," 11 inflorescences of this variety had an average of 17.3 per cent. of sterile spikelets.

Reference has already been made to the greater liability to thrips injury of the late flowering varieties and the foregoing percentages support this opinion. The "Banner" variety is one of our late flowering varieties and both percentages and field observations showed that it was more subject to the production of sterile spikelets by the thrips. Mr. G. Hutton, who studied cereal crops in Alberta during the summer of 1913, informed me that "Banner" oats suffered most from sterile spikelets in Alberta where he noticed the occurrence of "white-ears" in oats near Red Deer and Athabasca Landing, Alta.

Description and Life History of *Anaphothrips striatus* Osborn.

The insect and what is known of its life history, etc., has been described by Hinds from whose excellent account the following has been mainly taken:

The length of the female (Fig. 19) is 1 to 1.6 mm. The general color is yellow with more or less dusky or brownish shading in some parts. Hinds states that the male is unknown.[1] I have never found male specimens, although Cary (1902) describes the male.

The eggs are reniform and vary in length from 0.265 mm. to 0.33 mm. and in width from 0.085 mm. to 0.145 mm. The full grown larva is fusiform and about 1.2 mm. in length.

[1] Hinds has informed us that he has found a few males since his memoir was written.

The life history is briefly as follows: The females continue to deposit their eggs on the leaves of the grass and the young larvæ develop through the fall until the snow covers the ground, but only the adults appear to survive the winter. The adults hibernate and appear to be able to withstand exposure to a temperature of −21° F. according to Hinds. In Canada, however, they are able apparently to withstand lower temperatures than this judging by the distribution of the injury.

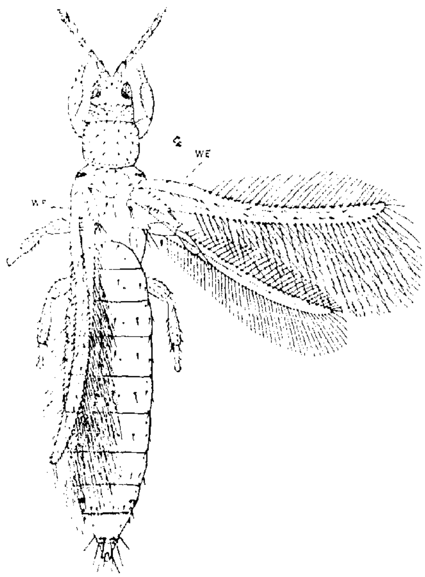

Fig. 19. *Anaphothrips striatus* Osb. (After Fernald and Hinds.)

In 1912, the lowest temperatures in Alberta were: Edmonton −46° F. and Calgary −30° F.; in Saskatchewan, at Battleford, −53° F., and Qu'Appelle −47° F.; in Ontario at Ottawa, the lowest temperature was −27° F. The females become active in the spring probably as soon as the snow disappears, and oviposition soon begins, lasting from four to six weeks in many cases. Each female is capable of depositing from fifty to sixty eggs. The eggs may be easily seen in the leaf by holding it before a light when they appear as small lightish spots; they may be separated from the leaf by stripping off the epidermis. The length of the egg state in the spring is from ten to fifteen days, and in the summer from four to seven days. The length of the larval stage

varies from two weeks in the early spring to about four days in midsummer. The winged adults appear in May or June. The whole life cycle occupies from twelve to thirty days. Korolikoff found that the species injurious to cereals which he investigated passed the winter in the green, soft tissues of the leaf sheaths of young plants, and that in the spring they migrated to the early cereals and later to the summer crops. He found that they migrated from one species of plant to another: for example, from rye to wheat and oats. He states that their injuries were caused chiefly by the fact that they feed upon the juices of the different parts of the flowers, and especially on the ovary, that is, in cereals, the young grain.

Other Species of Thrips Attacking Oats

Hinds, (l. c.) records the following species as attacking oats: *Æolothrips fasciatus* Linn., and *Limothrips avenæ* Hinds.

Control Measures.

As *Anaphothrips striatus* feeds on grasses and is able to migrate with the greatest ease, the difficulties of control would appear to be very great. The destruction of weeds, especially Gramineæ, is essential, and this would also apply to volunteer crops. As the insects hibernate in places where they have been feeding, such as the stems of cereals which have been cut and have died down, under rubbish and in crevices, the hibernation period would appear to afford one of the best opportunities for employing control measures. Such measures would be of a cultural nature, such as deep ploughing of the soil. As an alternative and additional measure the burning of the stubble of an infested crop would undoubtedly destroy large numbers of the hibernating individuals. Grain which has been infested might be cut as early as possible to prevent the further reproduction of the thrips. After threshing, the screenings and chaff, which contain large numbers of the insects, should be burnt. Where early varieties of oats can be grown advantage may be taken of the fact that these are less likely to be injured than the later ripening varieties. Korolikoff recommends the sowing of "bait" or "trap" crops. He suggests that rye or oats sown round the fields under cultivation about a fortnight before the sowing of the winter cereals might attract the thrips and afford them shelter while the crops are growing. When the trap crops are removed later a large number of the thrips are removed also.

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MR. W. E. HINDS: It is a normal habit of these insects, particularly in the younger stages, to feed on the leaf sheaths or stems. I am sure that Doctor Hewitt's observations on the young actually feeding on oat stems is correct and I do not think there is any doubt of their being capable of causing the trouble mentioned in his paper.

MR. C. GORDON HEWITT: There are two types of injury; one where the stem is attacked and another where sterility is produced by the insects actually attacking the ovaries and anthers.

MR. W. M. WHEELER: As Doctor Hewitt has said, he has been dealing with a case of parasitic castration. Since the reproductive organs of the oat plant abort through lack of nutriment, we may conceive this castration to be brought about either by such insects as thrips or by parasitic plants, such as certain species of moulds.

MR. HERBERT OSBORN: We had a case at the Experiment Station in Iowa many years ago of apple blossoms being attacked by another species of thrips in which the same condition was produced. Sterilization of the blossom resulted before the bloom opened. We were unable to find any fungus disease there.

MR. C. GORDON HEWITT: This question of sterility was first sent to the Dominion Department of Agriculture with the idea that it was caused by bacteria or fungus.

PRESIDENT P. J. PARROTT: The next paper is by Mr. C. L. Metcalf, entitled "The Egg-Laying Habits of the Pecan Twig Girdler."

EGG-LAYING HABITS OF THE PECAN TWIG GIRDLER

By C. L. METCALF, *Raleigh, N. C.*

(Withdrawn for publication elsewhere)

MR. H. T. FERNALD: A resident of Massachusetts had a grove of pecan trees in the state of Mississippi and he found that this beetle

was causing so much damage that he secured no income from his investment, and finally sold the property at a loss.

PRESIDENT P. J. PARROTT: The next paper, entitled "Notes on the Life History, Distribution and Efficiency of the Egg Parasite of the Chinch Bug," will be presented by Mr. J. W. McCulloch.

A PARASITE OF THE CHINCH BUG EGG

By JAMES W. MCCOLLOCH, *Assistant Entomologist*, and H. YUASA, *Student Assistant*, *Kansas State Agricultural College*

INTRODUCTION

Probably very few insects have received the attention from entomologists that the chinch bug has. Without a doubt the chinch bug is the most serious pest with which the farmers of the grain belt have to contend, and the amount of damage done by it in the last sixty years reaches into the hundreds of millions of dollars. Every experiment station in the area mentioned has at some time carried on investigations relative to the chinch bug, and it has been thought that the life history and economy of this insect was well understood.

Of all the staple crop insects, the chinch bug has been the only one for which there is no insect parasite. Prof. F. M. Webster[1] says "there may sometimes appear hymenopterous parasites of the eggs, but we have as yet no proof of the existence of such in this country, and only suspect the possibility of such a phenomenon because other allied species have similar enemies, which destroy their eggs." In April, 1913, the writers collected chinch bug eggs in the field which bore signs of parasitism, and later parasites were bred from these eggs which Mr. A. B. Gahan, entomological assistant, United States Bureau of Entomology, has described under the name *Eumicrosoma benefica*.

HISTORY OF DISCOVERY

In the course of a series of experiments conducted by the department of entomology of the Kansas State Agricultural College on the life history of the chinch bug, a large number of eggs were collected in the field to determine the first appearance of young bugs and the mortality of the eggs. The eggs, which were collected at different intervals and in different localities, were examined daily. While thus examining the eggs it was noticed that some of them were becoming dark in color instead of assuming the usual red coloring. These eggs were isolated and on May 19 there emerged from them three parasites.

[1] [illegible] 69, U. S. Bur. of Ent.

Classification and Original Description

Eumicrosoma benefica Gahan is a very minute insect belonging to the hymenopterous family *Proctotrypidæ* and to the sub-family *Telenominæ*. Mr. Gahan [2] has erected a new genus and species for this insect. He places the genus near *Tiphodytes* but readily separates it from that genus by antennal and venational characters. The following technical description of the species is taken from Mr. Gahan's paper:

FEMALE.—Length .75 mm. Head from above more than twice as broad as long antero-posteriorly, the vertex faintly sculptured, face perfectly smooth and polished, the region below the eyes faintly punctured; antennal scape not quite reaching the front ocellus; pedicel longer than joints one and two of the funicle combined; funicle five-jointed, the joints sub-equal, not longer than broad; club four-jointed, joint one much larger than the last funicle joint, but smaller than the following club joints which are equal and sub-quadrate. Mesoscutum faintly reticulated anteriorly, the disc perfectly smooth and highly polished with a very few small round punctures; scutellum, postscutellum and true metanotum smooth without punctures; propodeum as described; anterior margin of the forewing to the apex of the venation with only a few short marginal cilia, beyond with long cilia, the longest being twice the width of the wing. First segment of the abdomen nearly twice as broad as long with coarse longitudinal striæ, second segment similarly striate at base and much more faintly so beyond to the apex.

Head and thorax shining black. Antennæ, palpi, legs including coxæ and the whole abdomen reddish yellow. Antennal pedicel and club slightly fuscous.

MALE.—Antennæ fuscous, sub-moniliform, without a distinct club; pedicel globose, thicker but not longer than the first funicle joint; funicle joints one, two and three slightly larger than the following; apical joint of the club as long as the two preceding joints combined; abdomen a little shorter than in the female and distinctly fuscous on the apical half. Otherwise like the female.

Life History Summary of Original Host

The life history of the chinch bug is so well known that it will only be necessary to give a very brief outline of it as it occurs under Kansas conditions. The chinch bug is found in all parts of Kansas, except in the extreme western counties. The adult bugs emerge from hibernation during the first weeks of April and eggs are found from the last of April to the first of July. The first brood reaches maturity during the early part of July and the eggs of this brood are found from the middle of July until October. The second brood begins to reach maturity about the last of August, although the majority do not reach maturity until the middle of September. These adults migrate to

[2] A large number of specimens of the parasite were sent to Mr. A. B. Gahan, entomological assistant, United States Bureau of Entomology, for describing. A full description of the genus and species appears in the Proceedings of The United States National Museum, vol. 46, pp. 442–43.

the grasslands where they pass the winter in the clump-forming grasses. The period of oviposition of the adults occupies the entire summer and with the exception of a week or two in July, eggs may easily be found in the field from the last of April until the first of October.

The Egg of the Parasite

Description—The eggs of the parasite have never been observed after they were deposited in the host's egg. Ovarian eggs or ova were examined many times. There never were found more than thirty ova in a female and these were grouped together in the ovary, their blunt ends towards the apex of the ovary and their tail-like portion bent around in every direction. Judging from the comparative size of the ova, the matured ovum is spatulate in shape with ovate body which tapers into a long stalk. The opposite pole tapers gradually and ends in a blunt point. The ovum, on an average, measures from .07 to .09 mm. in length and from .02 to .03 mm. in width. The stalk is about two fifths of the entire length and is slender and cylindrical. The micropyle is located at the tip of the stalk. The ovum is nearly transparent and the granular character of the cytoplasm is plainly visible. The nucleus, which is comparatively large, is located as a rule near the blunt end of the ovum.

Length of Egg Stage—So far it has not been possible to find the egg of the parasite in the host, and so the exact length of the egg stage has not been determined. However, the very young larva has been found shortly after it has hatched, and thus the time between oviposition and the time the young larva was first seen varies from two days to about a week.

The Larva of the Parasite

Description—Since it has not been possible to get the larva of the parasite out of the host's eggs, a detailed description cannot be given at this time. Looking at it through the shell of the host it appears oval in shape and the segmentation is very indistinct. As the larva grows the body contents become plainly visible.

Length of Stage—The length of the larval stage varies with the climatic conditions. Although during the summer the growth is very rapid and the stage may be passed in from five to seven days, it may range from ten to fifteen days. In one case a larva shortly after hatching measured .12 mm. in length and nine hours later it measured almost .6 mm. The growth of the larva occurs practically altogether during the day time.

Feeding of the Larva—Just how the food enters the larva has not been determined, but after it gets within the body it is constantly churned back and forth by contractions of the body. These contrac-

tions may start from either end of the body and move to the other end. There are about three contractions starting from the anterior end to two from the posterior end and there are about two contractions per minute.

The Adult Parasite

Emergence—In emerging the parasite cuts a zigzag opening, by rasping and tearing with the mandibles, around three fourths of the anterior end of the egg. Then by pushing with the abdomen and legs the cap is pushed back with the head. The head is thus forced out and the parasite feels around with its antennæ. Then by continually working the legs within the shell and by extending its abdomen back to the posterior end of the shell it finally gets the front legs free. Then by pulling with the front legs and pushing as before it gradually works the rest of the body free from the shell. The time of day when emergence occurs varies with the temperature. During the spring when the temperature at night fell below 50° or 60° F., the emergence occurred between 9.00 a. m. and 9.00 p. m. From June 2 until September 8 when the temperature at night was above 55° or 60° F. the emergence occurred for the most part between 9.00 p. m. and 9.00 a. m. From September 8 on with temperature conditions the same as in the spring the emergence occurred during the day.

Relation and Economy of Sexes—In a number of experiments conducted to determine the relation and economy of sexes it was found that where a male is supplied to each female a higher percentage of parasitism was obtained. It was also found that a greater number of parasites reached maturity under these conditions. Table I gives the results of these experiments:

TABLE I.—SHOWING THE RELATION AND ECONOMY OF THE SEXES

No. of Trials	No. of Females	No. of Males	Ave. per cent of eggs Parasitized	Ave. per cent. of Mortality of Parasites	Ave. No. Eggs Parasitized per Female
9	2	2	53.4	27.	5.[illegible]
10	1	1	51.2	23.4	6.[illegible]
9	2	1	52.6	39.2	4.[illegible]
8	3	1	26.1	38.9	1.[illegible]
1	4	1	12.5	100.	[illegible]
1	5	1	7.5	33.3	[illegible]
4	1	2	37.3	25.3	6
1	1	3	25.	50.	2

Number of Eggs—It was not possible to determine with any degree of accuracy the number of eggs a female could deposit. Nineteen individual females parasitized an average of 6.2 eggs; seventy-six females of the first generation parasitized an average of 4.[illegible] eggs; sixty-three females of the second generation parasitized an average

of 3.7 eggs; thirty-one females of the third generation parasitized an average of 3.7 eggs. The largest number of eggs parasitized by a single female was 13.

Twenty-nine females, that had not been allowed to oviposit, were dissected and the number of eggs in the ovaries counted. The smallest number of eggs found was 13, and the largest 29, while the average was 22.8.

Proportion of Sexes—The number of females greatly exceeds the number of males both in the field and in the laboratory. Of fifty-one parasites collected in the field, forty-seven were females, and of the 786 parasites bred out in the laboratory, 512 were females. The number of females bred out in the laboratory is low because of several cases of parthenogenesis in which case the parasites obtained were all males. On an average about 70 to 75 per cent of the parasites obtained in the laboratory were females.

Parthenogenesis—This insect can breed parthenogenetically, but the number of eggs parasitized per female was usually low, and many of the offspring failed to develop. Fifteen trials were made with unfertilized females, and in four cases no oviposition was noticed. Of the 120 eggs parasitized by unfertilized females 50 failed to reach maturity. Seventy parasites were bred out and 66 of them were males.

Habits in the Field—The short existence of the adult is occupied in constant activity during the day in hunting for mates, and ovipositing. Feeding, if any, requires a very short time, and the main part of the insect's life is directed towards reproduction. In the wheat fields the parasites were always moving about on the plants near and below the surface of the ground. Unless disturbed, the adults seldom take to the wing. Generally only one parasite was found at a time, but occasionally two or more were found in a very small area. Although it seems probable that they spend their lives in comparatively limited areas, they also distribute themselves to a greater extent than might be expected. It is probable that the wind aids greatly in this.

Food—The parasites were never observed to feed in the field, but in the laboratory they fed readily on the sweetened water supplied them.

Flight—The flight of this insect is by short jerky flights. Just how far they may fly at one time has not been determined. They have been observed to fly from a leaf of corn five feet from the ground, but from here the flight could not be followed. In the laboratory the flights were generally short, covering only a foot or two.

Effect of Oviposition in Different Stages of the Egg—The parasites seem to prefer those eggs in which the chinch bug embryo

had not yet begun to show the reddish color. In several experiments in which parasites were introduced to red eggs, there was only one case where the parasite developed and destroyed the embryo. Of the eggs collected in the field, only four red eggs were found that later gave up parasites.

Host Relations—In all of the experiments, the chinch bug egg was the only one in which this parasite would oviposit. A number of experiments were conducted in which parasites were given eggs of false chinch bugs, and other hemipterous eggs, but no parasitism occurred.

Length of Adult Life—Owing to the fact that the adults were kept in small vials and without food, there is little doubt but that the length of life was greatly shortened. The length of life varies greatly, ranging from a few hours to twenty-five days. Temperature has much to do with the length of the adult life. During the spring the adults live on an average of about 93 hours. From June 9th to September 1st the average was from 40 to 60 hours, and after September 1st the average was considerably over 100 hours, in some cases reaching 350 hours.

Food also plays a large part in the length of life, and the more often the parasites are fed the greater the length of life. Table II shows the results of feeding parasites.

TABLE II.—SHOWING EFFECT OF FOOD ON THE LIFE OF THE FEMALE

Fed			Check	
No. of Parasites	Times fed	Av. Length of Life	No. of Parasites	Av. Length of Life
3	1	74 hours	4	33.4 hours
2	2	75½ "	3	54.3 "
3	3	115 "	4	54.2 "
5	9	264 "	7	102.8 "
1	12	414 "	3	152.3 "

Length of Life Cycle

The length of the life cycle was found to vary with the temperature. The average time between the collection of chinch bug eggs and the emergence of the parasites in May and June was 13.9 days for 81 individuals.

The average length of the life cycle for the second generation was 14.3 days, for the third generation 11.9 days and for the fourth generation 9.9 days. Owing to the scarcity of chinch bug eggs at this time, it was impossible to continue the brood study for about two weeks. From the last of July to the first of September 249 parasites were bred from eggs collected in the field, and the average time between collec-

tion and emergence was 9.8 days. The average length of the life cycle for the sixth generation was 15.2 days; for the seventh generation 17.6 days, and for the eighth generation 27.8 days. Table III gives the brood study.

TABLE III.—SHOWING THE AVERAGE LENGTH OF THE LIFE CYCLE

Brood	Source of Material	Date	No. Parasites	Av. Length Life Cycle
1	Eggs collected in field	4 28-5 27	81	13.9 days
2	From 1st brood	5 20-6 24	61	14.3 "
3	From 2d brood	6 5-6 13	45	11.9 "
4	From 3d brood	6 20-6 24	8	9.9 "
5	Eggs collected in field	7 19-9 6	249	9.8 "
6	From 5th brood	7 28-9 3	157	15.2 "
7	From 6th brood	8 16-9 7	106	17.6 "
8	From 7th brood	9 1-9 14	55	27.8 "

First Appearance in Spring. Inasmuch as the first parasitized chinch bug eggs were found on April 28, it is certain that the parasites were out before this date. The first chinch bug eggs were found in the field on April 24.

Last Appearance in Fall.—The last parasite observed in the field this fall was on October 14. A parasite was bred out from a clump of crab grass that had been brought into a warm room on November 6, but the probability is that it was hibernating as a pupa in a chinch bug egg.

Number of Generations.—The exact number of generations has not been worked out, but there are about nine or ten. From May 19 to July 5 there was obtained four generations of adults in the life history work. At this time the chinch bug eggs became very scarce, as it was the interval between broods, and thus it was not possible to carry on the life history again until July 23. From then on until October there was obtained four more generations. The interval during which the life history work was forced to be dropped was about two weeks, or almost the length of the life cycle, so that it would appear that there might easily be nine generations a year.

Distribution

This parasite was first discovered during the spring in chinch bug eggs collected in a wheat field near Manhattan. During the summer it was found in every grain field around Manhattan, and, in fact, every place where chinch bug eggs were found. In August a hasty survey of the state was made, and parasites were found in the following counties: Ellis, Ford, Kiowa, Ellsworth, Kingman, McPherson, Harvey, Sumner, Cowley, Riley, Pottawatomie, Montgomery, Allen,

Atchison, Leavenworth and Cherokee. In fact, parasites were found wherever material was collected, and the area given includes practically all of the chinch bug infested region in the State.

Percentage of Parasitism in Different Localities

The average percentage of parasitism of chinch bug eggs collected from various parts of the State outside of Manhattan was 16 per cent. Table IV shows the record of the collection of eggs and the per cent of parasitism.

TABLE IV. SHOWING PERCENTAGE OF PARASITISM IN VARIOUS PARTS OF THE STATE

Place Collected	Date	No. of Eggs Collected	Per cent Parasitized
Crawford	May 27	116	16.3
Pottawatomie Co.	Aug. 5	55	30.9
Dodge City	" 16	85	18.8
Effingham	" 18	130	15.4
Winfield	" 19	211	24.1
Columbus	" 19	72	12.5
Iola	" 20	79	15.2
Independence	" 21	59	15.2
Hays	" 23	17	17.6
Newton	" 25	47	14.9
McPherson	" 27	14	14.3
Conway Springs	Sept. 3	178	3.9
Kingman	" 4	111	7.2
Greensburg	" 5	5	20.

At Manhattan the average percentage of parasitism for the summer was 32.1 per cent. The greatest number of parasitized eggs were found in the corn field both on the corn plants, and in the crab grass.

TABLE V.—SHOWING PERCENTAGE OF PARASITISM OF CHINCH BUG EGGS AT MANHATTAN, [illegible]

Month	Total No. Chinch Bug Eggs	Per cent. of Eggs Parasitized
April	309	33.8
May	2232	19.
June	572	22.9
July	96	40.5
August	570	38.
September	232	38.7

Chinch bug eggs are often laid in bunches of two or more, and it is interesting to note that the percentage of parasitism is very high in such cases, ranging from 75 to 100 per cent.

Efficiency—The average percentage of parasitism over the state of 16 per cent does not represent the actual number of chinch bug

[1] This percentage of parasitism over the state is much lower than that at Manhattan, because it is based on only one collection of material and this material was often collected at a time when chinch bug eggs were scarce in the fields.

eggs destroyed. The period of oviposition of the chinch bug covers about two months, while the life cycle of the parasite covers a period of only two or three weeks. Thus the eggs of a single female chinch bug are exposed to about three broods of parasites, while the eggs of one brood of chinch bugs are exposed to four or five broods of parasites. Therefore, the percentage of parasitism for a brood of chinch bugs is at least 50 per cent. Experiments conducted in the field and in the laboratory show this to be true.

PRESIDENT P. J. PARROTT: The next paper on the program is entitled "Parasites of the San José Scale in New York—Species and Distribution," by H. E. Hodgkiss and P. J. Parrott.

THE PARASITES OF THE SAN JOSÉ SCALE IN NEW YORK

By H. E. HODGKISS and P. J. PARROTT

(Abstract)

Parasites of the San José Scale were numerous during 1913 in New York. To determine the range and species of these insects, infested wood was collected from unsprayed trees in the more important fruit districts of the State. This was obtained from twenty towns representing thirteen counties. From the material we reared the following species.—*Prospaltella perniciosi* Tower, *Aphelinus fuscipennis* Howard, *Aphelinus diaspidis* Howard, *Signiphora nigrita* Ashmead, and *Perissopterus pulchellus* Howard. The last two species mentioned appear to be of comparative unimportance. Taking the state as a whole our breeding records for September and October 1913, indicate that *perniciosi* was probably the most numerous species during that period. *Diaspidis* was numerically greater in two counties while *fuscipennis* ranked first in three counties. It should also be recorded that a count of nearly 800 parasites collected at random showed that about one-half of the specimens were *perniciosi*, one-third were *diaspidis* while the remainder were *fuscipennis*.

Considerable interest has lately centered on the efficiency of parasites to hold the scale in check. To determine the ratio of parasitism numerical counts were made of the scales after the rearings of the parasites were completed. Some twenty thousand individuals were examined of which about thirty-five hundred contained exit holes of the hymenopterons. The percentage of scales affected was variable and on the average ranged between 12 per cent and 24 per cent for the entire state. Locally the range was greater and the tabulations based on wood collected at Geneva showed a difference of from 0 to

35 per cent. This variation in the percentages of scales attacked occurred on individual trees as well as on limbs or smaller branches of the same tree. Of two samples of wood taken from the same branch, one gave no external evidence of the work of the insects while on the other 10 per cent of the scales were parasitized.

In our studies some attention was also directed to the occurrence of parasites in orchards which have been regularly sprayed with the lime-sulphur solution. It is of interest to note that in some instances 12 per cent of the scales were destroyed by the hymenopterous. An examination of fifty large collections of wood from two orchards that have been treated with the above spray for a number of years gave an average of 7 per cent of parasites for each planting.

Interesting as are these statistical accounts it is perhaps hardly necessary to urge the danger of attaching positive values to the above figures. It is apparent from our studies at the present time that the parasites vary a good deal locally both in numbers and in the relative importance of the different species.

A member: It might be interesting to note in this connection that San José scale is sometimes controlled by fungus disease particularly during the wet weather.

Mr. E. P. Felt: I would like to ask Doctor Howard whether he has any information as to the possible value of these parasites for controlling San José scale in the future?

Mr. L. O. Howard: It is guess work. I am quite positive, however, that newspaper advertising of the parasite work on the San José scale is going to hurt the fruit-growing industry, because it will result in many people giving up spraying. We do not know the intimate relationships of the different species of parasites of this insect and considerable study will be required before this information can be secured. We used to think that when a parasite emerged from a scale insect it was responsible for the death of the scale, but this is not always true because the species concerned may be a secondary parasite.

Mr. W. E. Rumsey: I was much interested in President Parrott's paper. During this season in West Virginia I found several orchards where the scales were more thoroughly parasitized than any I have ever seen before.

Mr. H. T. Fernald: I have been watching the parasites of the San José scale in Massachusetts for eight years and their numbers have been discouragingly small during that time. In the fall of 1912, however, quite a large number of parasitized scales was found and

suspecting that something unusual might be going on I had one of my students make collections and from these he bred out two species of parasites in proportions of perhaps 98 per cent and 2 per cent. In these collections about 80 per cent of the scales were parasitized. The parasites which emerged in such large numbers were sent to Doctor Howard who reported that they were a new species and the original description was accordingly published in the *Annals of the Entomological Society of America* for March, 1913, by Mr. D. G. Tower. As a result of the observations which have been made, we find that during the past fall in some localities 90 per cent of the scales are parasitized. It seems to me that we are in a position of the bacteriologist who is able to furnish pure cultures and I am ready to make a proposal in spite of what Doctor Howard has said, to the effect that we will send a few parasitized twigs to any entomologist who is interested in the matter. I agree with Doctor Wheeler that if 90 per cent of the scales are parasitized, the remaining 10 per cent will, nevertheless, furnish an abundant supply for reproduction. If the percentage of parasitism increases as it has in the past two years the results ought to be helpful. Our best results have been secured from collections made from unsprayed trees such as Cornus and Salix.

Mr. A. C. Lewis: I have only seen one or two cases in Georgia where the fungus disease did any particular good in destroying the San José scale. I do not think it can be depended upon as remedy in this state.

President P. J. Parrott: The next paper will be presented by Mr. V. E. Shelford.

THE IMPORTANCE OF THE MEASURE OF EVAPORATION IN ECONOMIC STUDIES OF INSECTS

By Victor E. Shelford

The economic importance of any environmental factor is determined by the character of its influence upon organisms of economic importance. Environmental factors influence organisms chiefly in one of three ways: (a) by stimulating migrating animals and causing them to turn back, (b) by producing death, (c) by modifying rate of metabolism, fecundity, length of life, size, etc. Recently attention of entomologists has turned to the study of optimum conditions for insect growth and rate of insect metabolism (Hennings[1], Sanderson[2], Headlee[3]). In these studies the chief criterion of increased meta-

[1] Zeit Land und Forst-Wirt, 5 jrg (a) p. 68.
[2] Jour. Econ. Ent., III, p. 113.
[3] Science, N. S., XXXVI, p. 310.

bolism has been the decrease in the length of the instars. Other indices of rate of metabolism in common use are: (a) the amount of carbon dioxide produced, (b) amount of oxygen consumed, (c) heat produced by the organism, (d) for aquatic animals susceptibility to weak cyanide has been shown to be an excellent method (Child[4]). Those organisms and parts which have the highest rate of metabolism go to pieces quickest. This method gives results exactly similar to that of the measure of the carbon dioxide with which it has been compared. Another method consists in measuring (*e*) the vigor of the behavior reaction (Allee[5]) which has been found to compare favorably with the cyanide results and measure of carbon dioxide. Thus animals with a high rate of metabolism are more sensitive to stimuli and react more vigorously than animals with a low rate. The study of reactions to measured physical factors can no doubt be used to advantage in the study of conditions affecting the organisms.

In a series of experiments the writer[6] has established gradients of evaporating power of air by passing air of three different kinds (rates of evaporation) across the respective thirds of a long narrow cage. These experiments showed that frogs, salamanders, toads, insects and millipedes are sensitive to variations in evaporating power, and turn back when they encounter air of an evaporating power greater or less than their optimum. The experiments also showed that after the animals had been in dry air long enough to have a small amount of water withdrawn, they became more sensitive to the effect of evaporation. The work on insects was not carried far by the writer but additional experiments by E. O. Deere and J. R. Watson support the original results.

In general the reactions were similar for comparable rates of evaporation no matter whether the evaporation was due to *dryness*, *temperature*, or *rate of flow*. Furthermore, death was produced with the same symptoms regardless of the cause of evaporation. There was usually a period of excitation following a short exposure and a period of depression, followed by death. The same disturbances which cause animals to turn back upon encountering air of high evaporating power result in modification of sensitiveness and in death if it is continued and intensified. These three means of influencing organisms are not to be regarded as independent of one another or essentially different because all result from interference with the internal life mechanism. The different results are dependent upon

[4] Roux Archives, XXXV, pp. 598–641.
[5] Jour. Expt. Zoöl., Vol. 13, p. 269–344.
[6] Biological Bulletin, Vol. XXV, p. 79, with good bibliography.

the character of the life mechanism in question and upon the kind and intensity of the stimulation.

Reactions to conditions in experiment, the condition selected and avoided, indicate the conditions suitable for the animals in nature. If such tests are made with reference to sufficient number and combinations of conditions and at a number of periods in the life history, much of a general nature concerning the relations of animals to environmental factors can be determined.

The reasons for the necessity of determining evaporation in connection with the effects of temperature, moisture, wind movement and insolation, may be summarized as follows:

1. The total effect of the air temperature, pressure, relative humidity, and average wind velocity upon a free water surface is expressed by the amount of water evaporated (Hann[1]).

2. The same factors have been shown to determine the amount of evaporation from the bodies of organisms (Reinhard[2]).

3. Metabolism results in heat and the temperatures of the bodies of animals both warm and cold blooded, is nearly always higher than the surrounding medium, at least during activity[3]. The surrounding conditions may be stated as usually acting on metabolism, etc., as follows: (a) A moist cold atmosphere (very low evaporation) causes body temperature to fall more rapidly than a dry cold one at the same temperature, because of the more rapid conduction of heat. Such a fall in temperature *decreases* metabolism of *cold blooded* animals, and *increases* metabolism of *warm blooded* animals within their capacity for heat regulation. In a dry cold atmosphere the heat loss is less pronounced because of the less rapid conduction of heat.[4] (b) In a dry warm atmosphere (high evaporation) rapid evaporation keeps down the peripheral temperature, and prevents death from overheating and destructive metabolism in cold blooded animals, and makes possible body temperature regulation and thus prevents heat stroke and death in warm blooded animals. In a moist warm atmosphere, death and heat stroke occur because of lack of evaporation and lack of peripheral cooling in the case of warm blooded animals even when the surrounding temperature is at or below the normal body temperature.[5] (c) Wind movement (which increases evaporation) increases radiation of body heat and of heat due to insolation. It increases evaporation and further cools the body, thus within

[1] [illegible]matology, p. 72.
[2] Z. f. für Biol., Bd. 5, p. 28.
[3] Schaeffer's Physiology, Vol. I, p. 793.
[4] Hill's "Recent Advances in Physiology and Biochemistry" ('06), p. 256.
[5] Hill's "Recent Advances in Physiology and Biochemistry" ('06), p. 256.

certain limits increasing the metabolism of warm blooded animals and decreasing it in cold blooded animals. (d) Decrease of pressure increases evaporation and radiation both of which lower the temperature of animal bodies and influence metabolism, as stated under (c).

4. Conditions which withdraw water from organisms (evaporation as influenced by various factors) influence irritability, activity and *length of life history. Thus Hennings found that low humidity* increased insect metabolism and Sanderson found that in dry air the optimum temperature of the growth of insects was lower than in moist air. Thus there are no doubt many exceptions to the usual rules as given under 3. Factors probably operate with reference to an optimum.

From the summary we have noted that water withdrawal is important in itself in many ways. Temperature is a much studied factor chiefly because of the ease with which it is measured in experiments with land animals, changes in temperature are always also changes in the rate of evaporation. Evaporation is best measured with the Livingston porous cup atmometers supplied by the *Plant World*, Tucson, Arizona, and which have proved themselves superior and are now essentially the standard instrument. Table I shows, as measured by these cups, the effect of raising temperature, on humidity and evaporation. The latter is nearly doubled by a rise of 10° C. such as takes place during a few hours of the usual summer day.

TABLE I.—SHOWING THE EFFECT OF RAISING THE TEMPERATURE UPON HUMIDITY AND EVAPORATION UNDER EXPERIMENTAL CONDITIONS. AIR PUMPED FROM A DRY GREEN HOUSE. VELOCITY OF FLOW OVER THE ATMOMETERS ABOUT .104 METER PER SEC. OR 0.2 MILE PER HOUR.[1]

	Unwarmed Air		The Same Air Warmed			
Temperature in Degrees Cent.	Humidity in Per Cent of Saturation.	Evaporation in cc. per Hour	Temperature in Degrees Cent.	Temperature Increase	Relative Humidity in Per Cent. of Saturation	Evapora[illegible]
19	37	1.4	30.0	11.0	17	[illegible]
14.5	38	1.5	25.5	11.0	19	[illegible]
22.6	37	1.6	27.5	5.0	25	[illegible]
22.6	37	1.6	32.6	10.1	18	[illegible]
22.0	32	1.6	38.0	16.0	14	[illegible]

[1] The atmometers were inclosed in inverted glass jars by means of large corks. The air was forced against the bottoms of the inverted jars from glass tubes just above and a little to one side of the apices of the atmometers and passed over the atmometers and out through an opening 2 inches below the effective portion of the porous cup. Thus the atmometers were not symmetrically exposed, which is usually the case in outdoor exposure. However the three atmometers used gave the same results for the same humidities and rates of movement. Symmetrical exposure should be attained by use of special glass vessels.

What is still more important is rate of flow, the effect of which is given in Table II, where we note that for very low rates such as are

TABLE II.—SHOWING THE RELATION OF EVAPORATION TO THE RATE OF FLOW AND TO RELATIVE HUMIDITY UNDER THE EXPERIMENTAL CONDITIONS, TOGETHER WITH THE RELATIVE RATE OF INCREASE OF EVAPORATION AND VELOCITY. (0.52 METER PER SEC. EQUALS 1.1 MILES PER HOUR, 0.68 EQUALS 1.5; 0.10 EQUALS 0.2). THE EQUIPMENT IS NOT ACCURATE ENOUGH TO MAKE THIS MORE THAN A GENERAL GUIDE. PRESSURE WAS NOT READ.

Approximate Velocity in Meters per Sec.	Approximate Evaporation in cc. per Hour	Temperature in Degrees C.	Relative Humidity in Per Cent. of Saturation	Ratios	
				Increase in Flow	Increase in Evaporation
.012	.25	22.4	50	1	1.0
.026	.40	22.2	53	2	1.6
.052	.75	22.2	53	4	3.0
.104	1.50	22.2	53	8	6.0
.208	2.00	22.2	54	16	8.0
.416	2.60	22.2	53	32	10.4

used for ventilating cages, *e.g.*, 0.026 meter per sec. gives .40 evaporation, while 0.052 meter per sec. gives .75, nearly double the evaporation at average humidity and room temperature. Evaporation should accordingly be measured, not only on account of its importance in connection with measured temperature and humidity, but also on account of the fact that rate of air movement is not otherwise measurable in terms which have bearing on the life processes of organisms.

MR. A. F. BURGESS: The conclusion given by Mr. Shelford in regard to the effect of moisture on the length of life of insects has proved true in many experiments which we have carried on at the Gipsy Moth Laboratory. In shipping live beetles from Europe and Japan, high mortality is usually caused by the drying out of the packing material. In cases where the packing material is moist on arrival the mortality is always low. The same principle applies in handling breeding jars.

MR. L. M. PEAIRS: Have you tables or other means of telling how much of the results secured were due to chemical action?

MR. V. E. SHELFORD: I have not attempted to determine that, and I do not mean by advocating the use of the atmometer that all these things can be determined, but this is the best means of getting at the total effect of all these agencies.

MR. C. GORDON HEWITT: It seems to me that unless Professor Shelford in his great ingenuity devises some machine to determine the amount of evaporation, which is due to the activity and metabolism of the insects, these studies will not lead us very far. We are dealing with only one of quite a number of factors.

Adjournment.

Proceedings of the Twelfth Annual Meeting of the American Association of Official Horticultural Inspectors

(Papers Continued)

QUARANTINE AGAINST THE MEXICAN COTTON BOLL WEEVIL

By W. D. Hunter

Compared with certain other pests the boll weevil has attracted little attention at the hands of legislators. It is likely that the Phylloxera in Europe and the San José scale in this country have been the cause of many times the amount of legislation that has been enacted against the weevil. Nevertheless, the restrictions that have been directed against it are numerous considering the time that it has been an important factor in the cotton industry and the inherent difficulties in formulating logical quarantines. As it is, every state in the cotton belt has enactments on its statute books which are aimed at the restriction of the spread of the weevil. One territory has similar legislation. The federal government has considered it in a statute and in regulations of the Post Office Department and several foreign governments have edicts against it.

The basis for all the quarantines against the boll weevil in the United States is that it has been spreading rapidly into new territory, and that its life history is such that certain commodities would be very likely to carry it. The natural limitation on all legal restrictions has been that the insect spreads by flight. This dispersion, however, is very limited compared to that of insects like locusts and others that fly over enormous distances. The usual annual advance of the weevil has been only about fifty miles. It is therefore apparently perfectly feasible to prevent spread which might take place in farm commodities over territory considerably more extensive than that which would become infested by the normal flight.

The specific points in the life history of the weevil which seem to justify quarantines in addition to those mentioned need to be noted in this connection. In the cotton-picking season large numbers of adult weevils are crawling about the cotton plants—frequently over the bolls and the exposed lint. Many of these specimens are naturally taken along with the seed cotton by the pickers. They go into the sacks, then into the wagons, and later to the gins. Here it has been found that many of the weevils escape destruction in the process of ginning. It is true that a certain number are killed by the saws of the gin and

modern cleaner feeders kill many more. The number of such feeders in actual use in the country is comparatively small, so that the escape of weevils from the gin must be considered important. In addition to the adult weevils that may be taken to the gin in the manner described, many of immature stages may be so transported. In fact these stages are considerably more important in connection with carriage in cotton products than the adults. It is not rare that the weevil larvæ, pupæ and teneral adults are found within the seeds themselves occupying the space originally taken by the kernel which has been devoured. All of the weevils of this class undoubtedly pass through the gins without injury. There are, moreover, two additional classes of immature weevils which occur in the cotton as it is picked in fields. One of these consists of pupæ imbedded in masses of lint. They form a definite cell which is very similar to cotton seed, although somewhat larger. These cells readily pass through the gins. The other class of weevils to be considered in this connection is contained in very small bolls. In the fall when the infestation in the fields becomes heavy it frequently happens that bolls of very small size are attacked. In many cases their contents are barely sufficient to support a weevil during its immature stages. Under such circumstances the carpel of the boll forms a perfect protection for the insect, in fact, a more thorough protection than the cells formed by the lint or by the shell of the seed itself. These bolls, therefore, carry many weevils through the process of ginning.

After the weevils have passed through the gins they are forced with the seed into the seed houses or sometimes directly into the cars. Examinations of seed being discharged by the blowers has frequently shown the presence of the insects. In a mass of seed the shelter for the weevil is almost perfect. In fact, their chances of passing the winter are nearly equal to those under the most favorable conditions in the fields. The weevil may remain in hibernation from October to June. If specimens happen to be located in seed an excellent opportunity for transportation over long distances is given. It would be perfectly easy for specimens to be taken from the United States to remote parts of the world in this way. A lot of infested seed shipped from Galveston any time during the fall would reach Egypt at the proper season to enable emerging weevils to attack the cotton there which is planted in the month of February. The planting season in India runs from June to August, depending upon the latitude and this would not interfere seriously with the introduction of the insect in that country.

In the United States the first quarantine restrictions were inaugurated in 1903,—the state of Georgia being the first to take such action. At that time apparently little was known about the habits of the weevils and the commodities in which they would be likely to be trans-

ported. This lack of definite information naturally led to enactments that were unnecessarily stringent. The legislators naturally desired to be on the safe side and therefore included many articles in the quarantine which experience has shown are not at all dangerous. Originally hay, oats, and other general farm products were quarantined against. In order to obviate very serious interferences with the marketing of Texas products it became necessary for the Bureau of Entomology in 1903 and 1904 to evolve a system of certifying shipments which originated outside of the territory infested by the weevil. In this way the disturbance caused by the broad quarantine measures that were enacted originally was relieved to the extent of several thousands of carloads of farm products which were certified by the Bureau of Entomology.

At the present time there are two types of quarantines against the boll weevil; one established by specific laws and the other formulated by boards under general authority. There is no doubt whatever as to the relative value of the different types. The first is very unsatisfactory on account of its inflexibility. There is no way short of legislative action to modify the quarantine in such respects as may become necessary on account of new information about the weevil; the other arrangement consisting of the delegation of general authority to boards makes it possible to change the list of articles to be quarantined and the territory against which it is directed as events change from year to year.

The following is a summary of the quarantine restrictions in the several states:

Alabama

The following are the restricted articles in this state.

Seed cotton; cotton seed; seed cotton sacks, cotton seed sacks and cotton pickers' sacks, any of which have been used within eight months for any of the purposes indicated. Cotton seed hulls between August 1 and December 31. Spanish moss and corn in shuck between October 1 and June 30. Living weevils or weevil stages or weevil work in possession of any person outside of the infested territory except a qualified entomologist. Household goods containing any of the foregoing during the period of quarantine applying to each.

The articles not restricted are as follows:

Baled cotton, flat or compressed; linters and loose cotton lint; cotton seed meal, cake and oil; corn shelled or in the ear with shuck removed, oats or any other seed except cotton seed; cotton seed shown by affidavit to have been sacked continuously for nine months or more; cotton seed for planting purposes after fumigation with carbon bisulphid by a competent entomologist; hay; empty freight cars.

California

In this state the boll weevil quarantine is in the form of an order issued by the state commissioner of agriculture on April 23, 1908. It provides that all cotton seed shipped into the state shall be consigned to one of the deputy commissioners of horticulture who is required to fumigate with carbon bisulphid.

Florida

The restrictions in effect are authorized by a general statute against pests which was passed in 1911. Special rules regarding the boll weevil were published in June, 1912.

The restricted articles are as follows:

Seed cotton; cotton seed; seed cotton sacks, cotton seed sacks and cotton pickers' sacks, any of which have been used within eight months for any of the purposes indicated; cotton seed hulls between August 1 and December 31; Spanish moss and corn in shuck between October 1 and June 30. Living weevils or weevil stages or weevil work in possession of any person outside of infested territory except a qualified entomologist. Household goods containing any of the foregoing during the period of prohibition applying to each. Sugar cane when not cut back and stripped of its leaves.

The articles not restricted are as follows:

Baled cotton, flat or compressed; linters and loose cotton lint; cotton seed meal, cake or oil; corn shelled or in the ear with shuck removed, oats or any other seed except cotton seed; cotton seed shown by affidavit to have been sacked continuously for nine months or more; cotton seed for planting purposes after fumigation with carbon bisulphid by a competent entomologist; hay; empty freight cars; sugar cane when cut back and stripped of its leaves.

Georgia

The law of August 15, 1904, was amended August 23, 1905. The regulations have been revised several times, last in October, 1913.

The restricted articles are as follows:

Seed cotton; cotton seed; seed cotton sacks, cotton seed sacks, cotton pickers' sacks which have been used within eight months; cotton seed hulls between August 1 and December 30; Spanish moss and corn in shuck or shucks removed from corn between October 1 and June 30; household goods containing any of the foregoing during the period of quarantine applying to each; living weevils in the possession of any person outside of the infested territory except a qualified entomologist and his certificate accompanying same.

The unrestricted articles are as follows:

Bales of cotton, flat or compressed, with no restrictions as to season;

linters and loose cotton lint; cotton seed meal, cake and oil; corn, shelled or shucked or with shucks removed, oats or any other seed except cotton seed; cotton seed shown by affidavit to have been sacked continuously for nine months or more; cotton seed for planting purposes only, after fumigation with carbon bisulphid by a competent entomologist; hay; empty freight cars.

Louisiana

The state entomologist of Louisiana is authorized to promulgate such quarantines as may seem advisable. Since the entire state is infested at the present time no regulations are in effect.

Mississippi

In this state there is an absolute quarantine against seed cotton, cotton seed hulls, sacks, and other articles. Baled cotton can be shipped into the uninfested parts of the state only in tightly inclosed cars.

North Carolina

The quarantine in this state in its present form was promulgated in June, 1910. It prohibits the bringing into North Carolina of all seed cotton or cotton seed hulls originating in any infested territory. Shipments of baled cotton are allowed only in hard compressed bales. If shipped in any other way it is declared to be a public nuisance and liable to seizure.

Oklahoma

The rules and regulations established by the state entomologist cover the usual cotton products, also provide that baled cotton can be shipped only in tightly closed box cars. The prohibition against the use of the quarantined articles, as bedding or feed for live stock in transit and as parts of general shipments consisting of household goods, is included.

South Carolina

The articles restricted are as follows:

Cotton seed and seed cotton for any purpose whatsoever are prohibited; seed cotton sacks, and cotton pickers' sacks, any of which have been used within eight months for any of the purposes indicated, are prohibited; cotton seed hulls are prohibited between August 1 and December 31; Spanish moss and corn in shuck are prohibited between October 1 and June 30; living weevils or weevil stages, or weevil work in possession of any person outside of the infested territory, except a qualified entomologist, are prohibited; household goods containing any of the foregoing are prohibited during the period of quarantine applying to each.

The articles not restricted are as follows:

Baled cotton, flat or compressed; linters and loose cotton lint; cotton seed meal, cake or oil; corn shelled or in the ear, with shuck removed, oats or any other seed except cotton seed; hay; empty freight cars.

Tennessee

The articles restricted are as follows:

Seed cotton; cotton seed; seed cotton sacks, cotton seed sacks; cotton pickers' sacks, any of which have been used within eight months for any of the purposes indicated; cotton seed hulls between August 1 and December 31; Spanish moss and corn in shuck between October 1 and June 30; living weevil stages or weevil work in possession of any person outside of the infested territory except a qualified entomologist; household goods containing any of the foregoing, during the period of quarantine applied to each.

The unrestricted articles are as follows:

Baled cotton, flat or compressed; linters and loose cotton lint; cotton seed meal, cake and oil; corn shelled or in the ear, with shuck removed, oats or any other seed except cotton seed; cotton seed shown by affidavit to have been sacked continuously for nine months or more; cotton seed for planting purposes after fumigation with carbon dioxide by a competent entomologist; hay, empty freight cars.

Texas

A rule of the commissioner of agriculture makes it illegal to ship seed cotton or cotton seed, or any other articles which might carry the boll weevil from an infested to an uninfested county.

Value of Quarantines

The most definite statement regarding the practical value of boll weevil quarantines in the literature was made by Mr. W. Newell as follows:

"Prior to the enforcement of quarantine regulations by the State Crop Pest Commission, many cases of isolated infestation occurred in the western parishes of the state, most of them being directly traceable to the bringing of seed cotton or cotton seed from the infested sections of Texas. Since the commission's quarantine regulations, which prohibit the movement of seed cotton, hulls and cotton seed from the infested to the non-infested sections, have been in force not a single isolated outbreak of the boll weevil has been discovered and all the northeastern and eastern portion of the state is, fortunately, still free from this pest. By means of this quarantine artificial dissemination of the weevil in Louisiana has been practically an impossibility and the spread of the pest into new territory has been limited

to actual flight; had it not been for the protection this afforded eastern Louisiana there is little doubt that the most of Louisiana's cotton-producing territory would now be infested, instead of the pest being confined entirely to the western parishes." (Circular 9, La. Crop Pest Commission.)

This statement may possibly be somewhat overdrawn, but the writer believes it is substantially correct. At any rate, with one exception (due to intentional introduction) no isolated colonies far beyond the territory reached by flight have ever been discovered. How much of this is due to the legal restrictions that have been described, and how much to accident, cannot be determined with certainty. It seems evident, however, that the possibilities for the spread of the weevil in certain classes of farm products are great. It is, therefore, altogether likely that many introductions have been prevented, and the writer believes the value of the quarantines has far overbalanced the temporary interferences with shipping that they have caused.

NOTES ON ENTOMOLOGICAL INSPECTION IN THE DISTRICT OF COLUMBIA

By E. R. Sasscer

Although there are no laws on the statute books of the District of Columbia governing the inspection of incoming and outgoing plants, every attempt has been made to examine such material. Until the enactment of the Plant Quarantine Act on August 20, 1912, this work was carried on by the Bureaus of Entomology and Plant Industry of the Department of Agriculture, and, subsequent to that date, has been conducted under the supervision of the Federal Horticultural Board. All plants entering or leaving the District of Columbia are inspected both from an entomological and a pathological standpoint.

There are two classes of inspection in the District of Columbia, namely, commercial and departmental. The former consists in the inspection of all imports for florists, department stores, and private individuals, and includes such plants as boxwood, azaleas, rhododendrons, roses, hydrangeas, orchids, etc. Since the first of the current calendar year some 496 cases of plants have been examined.

"Departmental inspection" includes the careful examination of all plants and plant products introduced and distributed by the Office of Foreign Seed and Plant Introduction as well as other offices of the Bureau of Plant Industry. Some 2,000 packages containing various plants and plant products have been examined during 1913. For the accomplishment of this work there has been provided a special quar-

antine house, which is properly equipped with suitable fumigation facilities, and is further provided with a stove, which is used to destroy all condemned stock. This house is sufficiently large to allow the opening of large containers, which may be fumigated without removal, should they contain any suspicious insects. Small packages of seeds, scions, and cuttings are examined in a room which is tightly screened to prevent the exit of very minute insects should they escape from the package at the time of examination. All plants regarded as suspicious are grown under observation in a greenhouse, which is used for this work alone and which is likewise tightly screened with a fine-mesh wire. An accurate record is kept of all plants and plant products introduced by the Office of Foreign Seed and Plant Introduction as regards their origin, destination, nature, quantity, and date of inspection.

Judging from the number of packages and boxes examined during the past year, one would naturally suppose that the inspection in the District of Columbia is comparatively light. As regards the number of plants examined, this may be true, but one must not lose sight of the fact that a very large percentage of the plants and seeds introduced by the Office of Foreign Seed and Plant Introduction originate in countries and localities of which we know little as regards their entomological and pathological status. For this reason all packages containing plants and seeds are thoroughly examined by representatives of the Federal Horticultural Board, and anything showing the slightest suspicion is either destroyed or grown under observation in quarantine. It may not be out of place to cite an example of the close inspection required to intercept pests coming in on stock from abroad. Some time ago cuttings taken from a peach tree which was supposed to have considerable value as regards the quality of fruit produced were received from Shantung, China. From a casual examination it appeared that these cuttings were free from injurious insects, but, on close examination, they were found to exhibit over the surface of the bark a few abrasions or scars, which, when opened, were found to contain from eight to ten eggs of a tree hopper. This stock was all destroyed and a second attempt was made to get an uninfested shipment of this material. On examination the second shipment was found to be likewise infested and was also destroyed. As to the amount of injury which this insect is capable of doing in the United States, should it become established, it is impossible to say, but, judging from the experience in the Mississippi Valley some years ago with a tree hopper (*Ceresa bubalus* Fab.), it would be decidedly disadvantageous to allow any insect of this nature to become established in America.

To show the possibilities of a close inspection, another shipment may be referred to which was inspected on May 26, 1913. This consignment consisted of mango plants in a wardian case from Java, and, on superficial examination, would probably appear to be free from injurious insects. These plants, however, were removed from the case, and a thorough examination revealed the presence of the following coccids:

Leucaspis indica Marlatt
Fiorinia theae Green
Pseudaonidia clavigera Ckll.
Pseudaonidia trilobitiformis (Green)
Aspidiotus dictyospermi Morg.
Aspidiotus palmae Morg. & Ckll.
Aspidiotus lataniae Sign.
Aspidiotus hederae Vall.
Parlatoria pseudaspidiotus Lindgr.
Vinsonia stellifera Westw.
Lecanium sp.
Pseudococcus sp.
Ceroplastes sp.

In addition to the coccids listed, some of the leaves were well covered with galls, resembling, in may respects, those produced by certain coccids on eucalyptus in Australia. Unfortunately, we were unable to detect any female insects in the galls, and, therefore, it was impossible to ascertain the real maker. Mangoes have also been received from India infested with *Phenacaspis dilatata* (Green), *Asterolecanium pustulans* (Ckll.), and an immature *Pulvinaria.*

In addition to the pests referred to, the following have been collected from time to time entering the District of Columbia on imported plants and plant products:

Potatoes (*Solanum* sp.). The Potato weevil (*Rhigopsidius tucumanus* Heller) was found to be infesting potatoes from Peru, Bolivia, and Ancud or San Carlos and Castro Islands, Chile. In addition to the weevil referred to there were also in the potatoes from Peru two species new to science representing also two undescribed genera. When examining these tubers the attention of the inspector was attracted to what appeared to be a dryness of certain parts of the peel, resembling somewhat the work of some leaf-miners in leaves. On opening these dry spots the weevils in question were found. The first shipment, which arrived in the month of May, included not only the adults but the larvæ and pupæ. A subsequent shipment, received on December 4 from Bolivia, exhibited only the adults of *Rhigopsidius tucumanus.* We have recently received from Mr. C. H. T. Townsend, who is located in Peru, information to the effect that occasionally potatoes reach the tables of second rate hotels containing cooked larvæ in their galleries.

Red mangrove (*Heriteria littoralis*). Pods of this plant from the Philippine Islands on examination were found to contain a number of Cryptorhynchid beetles, which, according to the authorities of the National Museum, represent undescribed species.

Mango (*Mangifera indica*). Seeds of this plant have been received from Mauritius, India, and Ceylon infested with the mango weevil. In order to realize the danger of such a pest if established in mango-growing sections, one has only to refer to Press Bulletin No. 17 of the Hawaiian Experiment Station by Mr. D. L. Van Dine. Seeds of mango have also been received from the Philippine Islands infested with a species of *Rhizoglyphus* which appears to be a dangerous pest.

Pistacia vera from Italy revealed a slight infestation with a scale insect known scientifically as *Diaspis gennadi* Leonardi. This is the first record of the appearance of this scale insect in America, and, in fact, is the only reference to this coccid since its description in 1898 on *P. terebinthus* from Greece.

Sugar cane has been received from the Philippine Islands infested with a species of *Odonaspis*. These canes also exhibited work which resembled very much that of representatives of the genus *Xyleborus*. In addition to the insects present, these canes were affected with a fungus, and the entire shipment was burned. A similar shipment of cane was received from Hawaii, and, owing to the fact that these plants originated from a country known to harbor serious enemies of this plant, they were ordered to be grown under supervision in the quarantine house. After some little time it developed that the canes in question were harboring eggs of the destructive leaf-hopper, *Perkinsiella saccharicida* Kirkaldy. The object in making this importation was to introduce into Porto Rico a special variety of sugar cane. Had these cuttings been passed and allowed to go to their intended destination, it would doubtless have resulted in the establishment of the sugar-cane leaf-hopper in this insular possession, eventually meaning great financial loss to the cane growers.

Date palm. A number of shipments of date palms imported from Egypt were found to be infested with the date-palm scales, *Phœnicococcus marlatti* (Ckll.) and *Parlatoria blanchardii* (Targ.). These coccids are of common occurrence on date palms and have been entering this country on these plants for a number of years. It is remarkable how the former species can get down between the various leaf sheaths of the plants in question. In fact, this scale has been found between sheaths that were so tight that they could not be separated without the aid of an ax. Secluding themselves as these coccids do, it is very obvious that it requires a special effort to detect and control pests of this nature.

Avocado. Avocado seeds have been received from Mexico and Costa Rica infested with the avocado weevil (*Heilipus lauri*). Little is known of the life history and habits and the possible injury occasioned by this insect in its native habitat. Badly infested seeds are

well riddled with galleries and rendered worthless. Adults in confinement have been observed feeding on the leaves and later attacking the woody portion of the plant, ultimately resulting in the death of the latter. A number of experiments have been conducted with the idea of determining if it is possible to fumigate infested seeds with safety. Owing to the long period required for germination it is impossible to give definitely as yet the effect of the fumigation on the seed. In so far as the insects are concerned all stages were destroyed. As soon as these experiments are completed a detailed report will be given, stating the method of fumigation and general effect on the insects and seed. In addition to the avocado weevil, seed have also been received from Mexico infested with a Scolytid, which may also prove to be a dangerous pest, should it become established.

Cotton. Seed of wild cotton from northern Transvaal were examined on October 11 and found to be infested with a very interesting bruchid which has not as yet been identified.

Aside from the pests listed, many others, some of which are new to science, have been taken during the course of inspection, but owing to the limited amount of time on hand, it is deemed wise to overlook them for the present.

NEW JERSEY STATE ANTI-MOSQUITO CONVENTION

A significant and interesting convention was held at the Hotel Traymore, Atlantic City, N. J., February 20 and 21, 1914. It was the annual meeting of the County Mosquito Extermination Commissions of the state, and was called to order at 2.30 p. m., Friday, February 20, by the temporary chairman, Dr. Ralph H. Hunt of East Orange. After a brief invocation by Rev. Henry J. Zelley, the mayor's representative extended a hearty welcome to the visiting delegates. Then followed a symposium on "Anti-Mosquito Work in New Jersey—Methods Employed and Results Obtained:" Essex County, Mr. Spencer Miller; Union County, Mr. Louis J. Richards; Hudson County, Mr. William Delaney; Atlantic County, Mr. Harold I. Eaton; Passaic County, Mr. J. S. Davison; Camden County, Dr. William A. Westcott; Cape May County, Mr. Joseph Camp; Bergen County, Mr. H. B. Vannote. These reports were of much interest, describing conditions found and giving the results of work accomplished, several being illustrated by photographs or lantern slides. Concluding the afternoon session was an illustrated address by Dr. T. J. Headlee, entomologist of the New Jersey Experiment Station, on the "Anti-Mosquito Work of the New Jersey Experiment Station." Doctor Headlee

showed the progress of the work and pointed out the marked increase in property values where the salt marshes had been drained.

The evening session was held in the auditorium of the Atlantic City high school where Dr. L. O. Howard, chief of the Bureau of Entomology, gave a very interesting lecture illustrated with lantern slides, on "Important Methods and Results of Anti-Mosquito Work in Various Parts of the World." Doctor Howard showed views in many lands and of particular interest were the portraits of the men who have made the principal discoveries connected with mosquito-borne diseases and with anti-mosquito work—closing by showing the portrait of the late Dr. John B. Smith.

Dr. Jacob G. Lipman, director of the New Jersey Experiment Station, in a brief address on "What Mosquito Extermination Means for New Jersey Agriculture" told of the inexpensive lands in southern New Jersey which had not become inhabited on account of the mosquito scourge.

A representative of His Excellency was present and made a brief address assuring the delegates that the executive department was in sympathy with, and would foster such anti-mosquito work as is now being done, which is clearly for the benefit of the state.

A film of moving pictures showing the development of mosquitoes from egg to adult and the various stages in ditching operations concluded the program for the evening.

The next morning the meeting opened at 9.30, and the first paper "Anti-Mosquito Work in New York State" by Dr. Joseph O'Connell, health officer of the Port of New York, was read by Doctor Headlee as Doctor O'Connell could not be present. In the next paper "Anti-Mosquito Work in Connecticut," Dr. W. E. Britton, state entomologist of Connecticut, explained what has been accomplished in that state, illustrated by lantern slides. This was followed by "Anti-Mosquito Work in Philadelphia," by Mr. Herman Hornig, entomologist of the City of Philadelphia. Mr. Hornig's paper was also illustrated by lantern slides.

Of especial interest was the next subject, "Mosquito Extermination Work from the Standpoint of the Taxpayer," discussed by Mr. A. W. Hamburg, president Newark Board of Trade; Mr. Walter A. Evans, director Essex County Board of Freeholders; and Hon. Carleton B. Pierce, Cranford, N. J.

At the close of the program, the meeting on permanent organization reported in favor of such action and submitted a constitution and by-laws and nominations for officers. The report of this committee was accepted and the following officers were elected for the ensuing year:

President, Dr. Ralph H. Hunt, East Orange, N. J.
First Vice-President, Dr. William Edgar Darnall, Atlantic City, N. J.
Second Vice-President, H. B. Vannote, Hasbrouck Heights, N. J.
Secretary-Treasurer, Thomas J. Headlee, New Brunswick, N. J.

The Executive Committee consists of these officers *ex-officio* and of the following members elected at large:

Mr. W. C. Hope, Roselle, N. J.
Dr. H. H. Brinkerhoff, Jersey City, N. J.
Mr. C. H. Cranmer, Manahawkin, N. J.
Dr. W. A. Westcott, Berlin, N. J.

The County Mosquito Extermination Commissions of New Jersey consist of the county health boards and where such boards do not exist are appointed by the justice of the Supreme Court, to serve without compensation, and the plan has resulted in obtaining men of exceptionally high standing to serve as members.

Considerable work has already been done in Union, Passaic, Essex, Hudson, Atlantic, Cape May, Bergen, and Ocean counties, and it is expected that the commissions in the other counties will soon start into activity. It is planned to publish the proceedings and to hold a similar convention each year.

Arrangements had been made to hold a demonstration of cutting ditches on the salt marsh in the afternoon, but on account of the weather, and as many wished to return to their homes, the plans were abandoned. The convention was a marked success, and the following sentiment was frequently expressed:—"What a pity that Dr. John B. Smith, who was really the father of this work in New Jersey, could not have been spared to be with us on this occasion." W. E. B.

THE GENUS PSEUDOKERMES IN MONTANA

By George B. King, *Lawrence, Mass.*

Pseudokermes cooleyi, n. sp. Adult female scale, four mm. in diameter, subglobose. Stramineous, very shiny, with four jet black irregular transverse bands, not linear, texture of scale thin. Boiled in caustic potash the derm is clear and tinged with yellow. Mouth-parts, very distinct, rostrum monomerous, rostral loop short and stout. The derm is not tessellated, no vestige of legs or antennæ visible, although the derm was clear, and if present could easily be seen. A number of embryo larvæ were present, but the young were not advanced enough to describe.

Hab.—On *Picea englemanni* at Corvallis, Montana, May, 1912. Collected by Prof. R. A. Cooley and I take much pleasure in naming this very interesting species after the collector. This is the third species of *Pseudokermes* to be described. The first was *P. nitens* Ckll. 1895, described from Brazil on *Myrtus* (*Blepharocalyx*) *tweedii* and the second *P. armatum* Ckll. 1899, described from S. Francisco del Val. Tobasco, Mexico, on *Palo de gusano*.

Professor Cooley has given me the following notes:

"The specimens I sent you were collected on a large *Picea englemanni* on the main street of the little town of Corvallis in the Bitter Root Valley, Ravalli County, Montana. The species Picea is of such wide distribution that this individual tree may have been introduced from a considerable distance or may have been taken from forests near by. I have attempted to trace the history of this particular tree and have failed. The probabilities are that it originated locally and that this *Pseudokermes* is native. The insects were not abundant on the tree."

A NOTE ON SIGISMOND MOKSHETSKY AND HIS WORK IN THE CRIMEA

By L. O. Howard

In my address on the recent progress and present conditions of economic entomology, published in the Proceedings of the Seventh International Zoölogical Congress and also in *Science*, New Series, Volume XXV, pages 769–791, December 6, 1907, I referred to Mokshetsky in the following words:

"Professor Mokshetsky is the Director of the Museum of Natural History in Simferopol, an institution which he has built up by his own labors. He has conducted many investigations in economic entomology, and has published a number of papers of value. Entirely through his influence, the Crimea, a most fertile country in which great attention is devoted to fruit growing, was perhaps the earliest locality in Europe in which American ideas in economic entomology were introduced. It was most interesting to walk, as I did on several occasions, through enormous orchards and see everywhere American spraying machinery and see the crops in as good condition as they could possibly be found in the most up-to-date region in the United States."

There was published nearly a year ago in Simferopol an account of the twenty years *jubilaum* of Mokshetsky, written by Theodore [illegible]rbakof, from which it appears that in 1912 twenty years of scientific work by this excellent economic entomologist were completed.

Mokshetsky[1] was born May 2, 1865, and was educated in Vilna, [illegible] entering the Forest Institute where he attended the entomological [illegible] lectures of Cholodkowski. He went into steppe forestry work, [illegible] afterwards became assistant forester in the management of the [illegible]ment property at Charkow. From 1890 to 1892 he devoted

[1] [illegible] name is variously spelled in English, for example as Moerzecki; but the [illegible] here used was personally given to the writer by Mokshetsky himself in 1907 [illegible] giving the sound of his spoken name.

himself to entomology in the Zoölogical Laboratory of Charkow University. He went to the Crimea in the spring of 1893. At this time insects were causing great damage, and he was freed from his administrative duties and began to take up direct work in economic entomology. He began immediately the study of *Eurygaster maura* Fabr., which had destroyed twenty-three thousand acres of winter wheat. He worked in the field, studying the insect, and the result of his work was the publication of a report upon this species which is said to have been the first work in Russia by an entomologist who was actually stationed for an extended space of time in the field. He pointed out the necessity of establishing a local entomological laboratory, but since there was no action upon this suggestion by the local or other authorities he conducted a laboratory in his own private house. Three years later the board of the local government gave him two rooms for his insectary and two hundred rubles (about one hundred dollars) a year. This was the beginning of the Zemsky Museum of Natural History. He soon filled his rooms with entomological collections and specimens of the fauna and flora of the Crimea, and, constantly urging the necessity for establishing a competent museum of natural history, he was finally able to make a formal opening in 1899. Since that time he has worked with constantly increasing efficiency and with slowly increasing support. He organized the Crimean Naturalists' Society and Society of Nature Lovers. He was a pioneer in the starting of entomological stations in Russia, and has given courses of lectures on entomology to land proprietors, instructors and agronomists. In recent years he has often gone to the Caucasus where he has helped to organize and conduct courses in entomology for the public school teachers, and has given instruction to practical entomologists, many of whom are now working in many parts of Russia. He is now the chief specialist in practical entomology in the Department of Agriculture. He was the first to introduce into Russia modern American spraying machinery and to adopt the up-to-date methods of American economic entomologists.

Not content with the great work which he has already done, he is now engaged in organizing an experiment station in pomology near Simferopol, which will include branches in entomology, mycology, chemistry and meteorology.

It is astonishing what this energetic fellow-member of our Association of Economic Entomologists has accomplished, beginning single-handed, and by the strength of his own force accomplishing success which attracted the attention and support of the local and Imperial governments. American entomologists I am sure will congratulate him and wish him at least another twenty years of successful work.

[illegible]MOND MOKSHETSKY, the Economic Entomologist of the Crimea, his family, his [illegible]tants and friends; taken in his garden at Simferopol, May, 1907. Mokshetsky is [illegible] from the left, standing; his principal assistant is fifth from the left, standing, [illegible] his artist is on the extreme left. The gentleman seated is personally known to [illegible] American entomologists.

THE USE OF ATMOMETERS TO MEASURE EVAPORATION IN THE STUDY OF INSECTS

By V. E. Shelford

The porous cup atmometer or evaporimeter, was first designed by Babinet in 1848. Subsequently, it was independently devised by several workers. B. E. Livingston was one of the last of these and his instrument has become the standard in this country and Europe. It consists of a cup of porous baked clay about 5 inches long and 1 inch in diameter. The cup is filled with water and a rubber stopper containing a small glass tube is inserted into the opening. It is placed cork end down and the glass tube is connected with a bottle or other reservoir of water. As water evaporates, the cup remains full and water is withdrawn from the reservoir. The amount withdrawn is the amount of water evaporated. Differences in evaporation are shown corresponding to changes in temperature, air moisture, air movement and air pressure. Black, brown or other colored cups are used to determine the effect of light. In sunlight, the colored cups show a greater amount of evaporation than the white ones. Cups of the color of the insects studied could probably be used to advantage.

The instruments have been found indispensable by numerous persons attempting to study and control the complete environment. They are used both in cages and in the field where they are the only instruments that record the effect of wind movement and exposure to the sun as well as temperature, etc., in terms of any physiological significance. Rain correcting device has already been invented by Livingston. The cups may be obtained from the *Plant World*, Tucson, Ariz., and details as to their use can be obtained from the files of that journal for 1910 and 1911. Reasons for the importance of the measure of evaporation based upon the study of literature, and some experiments are given by the writer elsewhere in the Association's Journal.

Prof. J. H. Comstock, for thirty nine years instructor and professor of entomology at Cornell University, has resigned and will retire from active duties at the close of the present academic year. The following expression of appreciation by the Board of Trustees was made public: "In accepting the foregoing resignation the trustees congratulate Professor Comstock on his long, honorable and fruitful service to Cornell University, with which as student and teacher he has been associated almost without interruption since he matriculated as a freshman, and they bear grateful testimony to his success in teaching and in inspiring students and also in scientific investigation, for the continuance of which they trust his health and energy may be preserved for many years to come to the honor of his alma mater and the advancement of truth and knowledge."

Scientific Notes

Gipsy and Brown-tail Moths. According to *News Letter No. 1*, of the Bureau of Entomology, a small gypsy moth infestation has recently been discovered in a suburb of Cleveland, Ohio, where a few egg-masses were found. The territory has been examined by scouts of the Bureau of Entomology and the Bureau in coöperation with the State Nursery Inspector will attempt to exterminate the colony.

Egg-clusters have been found in several towns in eastern Connecticut during the winter, by scouts of the Bureau of Entomology. The pest has apparently spread into Connecticut from Rhode Island and Massachusetts. No egg-clusters were found at the old infestations (Wallingford and Stonington) by either state or federal scouts. No egg-clusters have been found this winter at Geneva, N. Y., where the pest was discovered more than a year ago.

There has also been a considerable spread of the brown-tail moth toward the South and West. Inspectors of the New York State Department of Agriculture found nests on Fisher's Island, N. Y., a small island off the coast of Stonington, Conn. In Connecticut nests have been found along the coast as far west as the Connecticut River, one nest being found in Saybrook, west of the river. In the northern part of the state one nest was found in Granby and four in Simsbury. These points are several miles west of the Connecticut River. It seems to be only a matter of a few years when all parts of the state will become infested, and the moths will probably soon reach the eastern end of Long Island, if they have not already done so.

W. E. B

Publications of the Bureau of Entomology. On July 1, 1913, the series of bulletins and circulars of the several bureaus and offices of the Department of Agriculture were discontinued and a general or departmental series to take the place of them was started. The Technical Series of the Bureau of Entomology was also discontinued and such entomological matter of this nature as is to be published by the department hereafter (*i.e.*, technical matter which is the result of original research) will appear in the new *Journal of Agricultural Research*.

The concluding number of the circular series is No. 173; of the bulletin series, No. 127, and of the Technical Series, No. 27. Bulletin No. 123 has just been issued, and Technical Series No. 26 will be issued in a week or so; these two will fill up the gaps in the two series.

As several of the bulletins and Technical Series bulletins which have been issued in parts are still incomplete, the bureau is to be permitted to complete these and this will be done during the next few months. Each of these bulletins, when complete, will consist of at least two parts and will have in addition an index or a Contents-and-Index part. An exception to this rule is Bulletin No. 83, which cannot, under the new plan of publication for the Department, be completed. Part I will be the only part of this bulletin issued, and there will be no index part.

(From *News Letter No. 1, Bureau of Entom*[illegible]

Notes on Three Imported Insects Occurring In New Jersey. A[illegible] (*Diaspidiotus*) *tsugæ* Marlatt., During the spring of 1910 hemlock imp[illegible] Japan was found to be badly infested by the above scale described by M[illegible] *Entomological News* for November, 1911. From the badly infested conditi[illegible] trees, it was considered an extremely unwelcome importation. In the rep[illegible] state entomologist by Dr. J. B. Smith published in the Proceedings of t[illegible] ninth annual meeting of the New Jersey State Board of Agriculture for 191[illegible]

Smith said: "It may be interesting to note that I believe that the entire infestation in New Jersey has been destroyed and if any specimens do exist they are accidental escapes left on the grounds when all infested plants were supposed to have been destroyed. There was no sale of this stock through the New Jersey nurserymen."

It is equally as interesting to note that in January, 1914, almost four years later, the scale was found in large numbers infesting Japanese hemlock in the same part of the state where it was originally discovered. It can therefore be said to have gained a slight foothold. Apparently some accidental escapes were left on the grounds when all infested plants were supposed to have been destroyed. This shows the need of extremely close supervision in the case of scale infested imported plants. It is unwise to try to pick out the infested plants and allow the apparently clean ones of the shipment to come through, especially when stray scales are likely to be overlooked. One can never be sure that the infestation has been entirely destroyed. An attempt will be made again to wipe this scale out of New Jersey.

Agrilus sinuatus Oliv. The work of this buprestid was first noted in New Jersey in 1894 at which time it did considerable injury to pears in orchards and nurseries in the northern part of the state. According to Bull. 109 of the New Jersey Agric. Exp. Sta. by J. B. Smith it was probably introduced from France. In "Insects of New Jersey" it is listed as being local in Essex, Union and Middlesex Counties, "an introduced species that is being gradually worked out." An additional county can now be added to the list, namely Bergen. While it is true that it is not abundant, every year, it is customary to run across its work in the northern part of the state. In spite of the fact that it is no longer destructive, it is evidently holding its own in a small way and spreading somewhat.

Kaliosysphinga dohrnii Tischbein. During the summer of 1913 this sawfly leaf miner was first noticed in New Jersey at Elizabeth on European alder, *Alnus glutinosa*, growing in a nursery. The leaves were mined so badly that the trees presented the appearance of having been swept by fire and the ground below was strewn with dried leaves. This insect was first described in Germany in 1846. While mentioned in Smith's "Insects of New Jersey," it is not recorded as occurring in New Jersey. An account of this leaf miner can be found in Bull. 233, Cornell University Agric. Exp. Sta., by M. V. Slingerland.

H. B. Weiss,

New Brunswick, N. J.

A Coleopterous (Clerid) Larva Predaceous On Codling Moth Larvae. This note is to give only a word concerning an enemy of the codling moth larva that is common in this locality. Not having seen reference to this enemy elsewhere, I give the note for the benefit of other workers and that more information may be obtained for myself. Any detailed observations made later here will be announced.

While examining some old bands for the codling moth in an abandoned orchard near Mesilla Park, N. M., October 20, 1912, I found a coleopterous larva in the ... a codling moth larva. The latter was limp, the greater part of its body ... g been sucked out.

The ... daceous larva was placed in the laboratory in a glass jar containing some ... fragments of tissue paper. A half dozen codling moth larvæ were placed ... In the spring I thought it had gone into the earth to pupate as I could ... s I had previously. So it was left until October 17, 1913. On that day ... paper was carefully removed and the larva was found snugly curled up ... tied cocoon of a codling moth larva. The codling moth larvæ had been ... re pupation. More of the food of this predaceous fellow was put in on ... d it remains thrifty to the present date.

In the last week in December I visited the large apple orchard of Mr. J. G. Stuart west of Mesilla Park, N. M. His trees were banded for the codling moth. He was well aware of the presence and beneficent work of his "warriors," as he called them, under the bands. On examining several of the bands I collected a number of the larvæ in question along with codling moth larvæ for their food. These were placed in the laboratory in hopes an adult might be reared.

Being in doubt as to the family to which the larva belonged, I sent specimens to Dr. L. O. Howard, Washington, D. C., and to Prof. H. F. Wickham, State University of Iowa, to both of whom I am indebted for their kindness in the matter of identification. Both reported that the larva was evidently that of some species of clerid. Doctor Howard stated that it was "apparently quite common in New Mexico." No specific indentification of the larva was attempted.

It is to be hoped that adults may be reared from the material on hand so the species may be determined. The long larval period of members of this family adds difficulties to this attempt. I have never yet noted adult clerids about the bands.

D. E. MERRILL.

The Twig Girdling Habit of Hemerocampa leucostigma by Caged Specimens. J. A. Lintner, in his second report as New York State Entomologist, 1885, pp. 86 [illegible] describes the extensive girdling of elm twigs by this species at Albany, N. Y., in 188[illegible] and states that he observed the same thing at Troy, N. Y., six miles north of Albany. In his eleventh report, 1895, he states that he has observed the same phenomenon in varying amount each year since 1883 and that in this year, 1895, that he observed it for the first time by the second brood of larvæ. Dr. E. P. Felt in Bulletin [illegible] New York State Museum, 1906, says that he has observed the same thing and in his "Insects Affecting Park and Woodland Trees," New York State Museum Memoir 8, Vol. 1, states that the habit has not been recorded from other places.

It is an interesting fact that the same thing happened with caged specimens at Purdue University, LaFayette, Ind., during the spring of 1913. On the 20th of May, 1913, a twig of new growth was noticed which had been eaten into for about 7 mm. in length and more deeply on the base end. At the tip end it was eaten about half way through and gradually became deeper throughout the 7 mm. of length so that at the base it was just hanging by the bark on the lower side. After the twig was cut off for photographing, a larva was seen feeding on the stub remaining in the cage. A few days later four or five more twigs were observed to be in the same condition, some being cut entirely off while others were only partially eaten. One twig was noticed in which the bark was eaten off irregularly for about an inch in length but the tissue beneath was not touched. In all cases only new wood was affected and it was all done by larvæ in their second instar. After they became older they did not touch the wood. It was not necessary for them to resort to the wood for food at any time, as there was always an abundance of tender leaves kept freshly standing in a bottle of water, and on which most of the larvæ fed. This habit was not observed out of doors.

P. W. MASON, *Agr'l. Exp. Sta., LaFayette, Ind.*

A Correction. My attention has been called by Mr. F. E. Brooks, who has made a study of the mammals of West Virginia, to the fact that the skunk or polecat mentioned in the February issue of the JOURNAL as feeding on the larvæ of the peach borer, was probably not *interrupta* which is not known to occur in that locality. It was more likely to have been either *Mephitis mephitis putida* or *Spilogale putorius*, both of which are known to occur in this locality, the former being the more common. (The locality in question was Keyser, W. Va.)

L. M. PEAIRS, *Morgantown, W. Va.*

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

APRIL, 1914

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. The receipt of all papers will be acknowledged.—EDS.

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The sectional meetings have some disadvantages since they have made possible the reading of many more papers within a given time and now we find ourselves with a very large amount of manuscript on hand without the means for publishing it promptly and at the same time provide for the usual additional matter appearing in later numbers. Our limited funds make it necessary to carry over a number of papers and for the remainder of the year contributions may be expected to appear from one to two issues later than originally estimated. We can hardly do more than complete the publication of the proceedings in the June number, and as a consequence some papers will not appear in time to be of the greatest service the coming season.

The large amount of matter and the relatively scanty means raises a question as to the most profitable expenditure of available funds. It has been the aim to restrict the papers largely to original contributions to knowledge, a policy which must be adhered to more rigidly in the future. The business proceedings of recent years are more voluminous and there is a tendency for them to increase in size with the more complete type of organization towards which we are tending. Many of these activities are highly desirable, some are of questionable utility and in certain instances at least the same end could be accomplished with less printer's ink. This latter is true of some contributions to knowledge though most of us find it easier to see the verbosity of the other man than to note such a trait in our own writings.

Current Notes

Conducted by the Associate Editor

A proposed anti-mosquito drainage law is now before the legislature of Massachusetts.

Mr. W. O. Ellis has been appointed instructor in entomology at the Washington State College.

Mr. George G. Ainslie of the Bureau of Entomology is now at work in Florida, with headquarters at Orlando.

Mr. T. J. Talbert has recently been appointed assistant in entomology at the Missouri College and Station.

Mr. Desla Bennion, who has been connected with the Salt Lake (Utah) State Bureau of Entomology, has resigned.

William H. Hasey, 1913, Massachusetts Agricultural College, is a graduate student in entomology at the college.

Mr. L. M. Gates has recently been appointed field expert in entomology at the Nebraska Agricultural Experiment Station.

Prof. N. E. Shaw, state nursery inspector of Ohio, addressed the Ohio Nurserymen's Association at Cleveland, January 21, 1914.

Mr. Harry W. Allen, 1913, Massachusetts Agricultural College, is now employed at the parasite laboratory, Melrose Highlands, Mass.

Mr. Henry L. Viereck, sailed on March 5, to collect parasites in Italy, France and Germany for the California Commission of Horticulture.

Prof. J. H. Comstock of Cornell University, has recently been elected one of the twelve honorary members of the Société Entomologique de Belgique.

Mr. S. B. Doten is now director of the Agricultural Experiment Station of Nevada. This is the fifth station to select an entomologist as its director.

According to *Science*, Dr. Creighton Wellman, dean of the school of hygiene and tropical medicine of Tulane University of Louisiana, has resigned his position.

Mr. W. S. Regan, chief deputy nursery inspector of Massachusetts, was operated upon for appendicitis at the hospital in Springfield, Mass., during the holidays.

Mr. Clyde M. Packard, a graduate of the Massachusetts Agricultural College, class of 1913, now has a position in the Bureau of Entomology and is stationed at Hagerstown, Md.

Mr. Roy E. Campbell, B.S., 1913, University of California, has accepted an appointment in the branch of Truck Crop and Stored Product Insect Investigations, Bureau of Entomology.

Mr. P. M. Eastman, Massachusetts Agricultural College, class of 1908, is inspector of nurseries for the New York State Department of Agriculture, with headquarters at Albany.

Mr. Ray T. Webber has been appointed as scientific assistant, Bureau of Entomology, and is now engaged in experimental work at the Parasite Laboratory, Melrose Highlands, Mass.

According to the *Review of Applied Entomology*, Mr. C. F. Beeson, Indian Forest Service, has been appointed forest Zoölogist to the Government of India, vice Dr. A. D. Imms, resigned.

Mr. George W. Barber has recently taken a position in the Bureau of Entomology and is located at Hyattsville, Md. Mr. Barber is a graduate of the Massachusetts Agricultural College, class of 1913.

Francis Jager has been appointed professor in apiculture and apiarist, and William Moore, assistant professor in entomology, at the University of Minnesota and the Agricultural Experiment Station.

Mr. L. L. Scott, Entomological Assistant, Bureau of Entomology who was assisting Mr. A. G. Hammar in codling moth investigations in the Pecos Valley, New Mexico, resigned from the service February 14, 1914.

Messrs. W. B. Wood and E. H. Seigler have been detailed for work during the spring months in California in connection with the Bureau's investigations and demonstration work in the control of the pear thrips.

Mr. Chester F. Turner, of the Kansas Agricultural College, has accepted an appointment in the Bureau of Entomology, Cereal and Forage Crop Investigations, and has been assigned to the Greenwood (Miss.) Station.

Mr. Curtis P. Clausen, B.S., 1914, University of California, has accepted an appointment in the Branch of Truck Crop and Stored Product Insect Investigations, Bureau of Entomology, with headquarters at Berkeley, Cal.

Mr. Joseph J. Pillsbury, a graduate of the Massachusetts Agricultural College, class of 1913, is engaged in field work on the gypsy moth in New Hampshire, with headquarters at the parasite laboratory, Melrose Highlands, Mass.

Dr. J. E. Wodsedalek, formerly of the department of zoölogy, University of Wisconsin, has been appointed head of the department of zoölogy and entomology at the Idaho University and Station, the position formerly held by Prof. J. M. Aldrich.

Mr. Lawrence P. Rockwood, a graduate of the Massachusetts Agricultural College, class of 1912, is employed by the Bureau of Entomology, and is located at Salt Lake City, where he is engaged in rearing parasites for the control of the alfalfa weevil.

Mr. W. F. Turner, Entomological Assistant, Bureau of Entomology, formerly assigned to work under the Insecticide and Fungicide Board, has been transferred to the Office of Deciduous Fruit Insect Investigations, and will assist Mr. Baker in studies of orchard plant lice.

A monthly *News Letter* will now be issued in the Bureau of Entomology, giving an account of changes in personnel, activities of divisions and men, and methods of work. The first number was issued in March, and the *News Letter* will be sent to all connected with the Bureau.

Dr. E. F. Phillips, in charge of bee culture investigations of the Bureau of Entomology, and Mr. George S. Demuth are conducting investigations on the temperature of the bee colony in winter, at the Zoölogical Laboratory of the University of Pennsylvania, at West Philadelphia.

Mr. ... J. Fabis, a graduate student of Columbia University, New York City, and formerly a student at Cornell University, has been employed as scientific assistant,

Bureau of Entomology, and will assist Mr. John B. Gill in pecan insect investigations, with headquarters at Monticello, Fla.

At the annual convention of the New England Nurserymen's Association, held at Hartford, Conn., February 24 and 25, 1914, the subject of pests and inspection was discussed by Prof. W. C. O'Kane, Durham, N. H.; Mr. D. M. Rogers, Boston, Mass.; Dr. G. P. Clinton and Dr. W. E. Britton, New Haven, Conn.

According to *Science*, Carlos E. Porter, professor of zoölogy and entomology at the Agricultural Institute of Chile and director of *Revista Chilena de Historia Natural*, is vice-president for 1914, of the Sociedad Cientifica de Chile and honorary professor of zoölogy at the Agricultural College of the University at Manaos, Brazil.

Mr. Boyd L. Boyden, who pursued a course in biology at Pomona College, Claremont, Cal., graduating as B.S. in 1912, has been transferred from work on tropical and sub-tropical insect investigations to the branch of Truck Crop and Stored Product Investigations, Bureau of Entomology, with temporary headquarters at Whittier, Cal.

Mr. Benjamin R. Leach, a student at Cornell University, has been appointed as scientific assistant in deciduous fruit insect investigations, Bureau of Entomology, and will give special attention to habits, in orchards, of the woolly apple aphis and to experiment with remedies in the control of this insect. Headquarters will probably be Winchester, Va.

The ninth annual convention of the Tennessee State Horticultural Society, State Nurserymen's Association, and State Beekeeper's Association, was held at Nashville, Tenn., January 28, 29 and 30, 1914. Prof. H. A. Morgan gave an address before the Horticultural Society, and Prof. G. M. Bentley addressed the Nurserymen's Association, of which he is secretary-treasurer.

Mr. John E. Dudley, Jr., formerly connected with the Gypsy Moth Parasite Laboratory at Melrose Highlands, Mass., has been appointed as scientific assistant in the Bureau of Entomology, and assigned to work under the Insecticide and Fungicide Board. He will assist Mr. E. W. Scott in testing the efficacy claims of manufacturers as regards their insecticides, with headquarters at Vienna, Va.

At the University of Kansas Mr. P. W. Claassen has been appointed assistant state entomologist on the staff of the state entomologist of the University of Kansas, who is a member of the entomological commission. Mr. H. B. Hungerford has been advanced to the rank of assistant professor. The Board of Educational Administration has recently made a special appropriation of $1,500 per year for the next biennium to be used by the state entomologist in charge of the southern half of the state in connection with his investigations on native grasshoppers. They have also granted him $300 additional appropriation for the investigation on pellagra and the sand fly.

Mailed April 15, 1914